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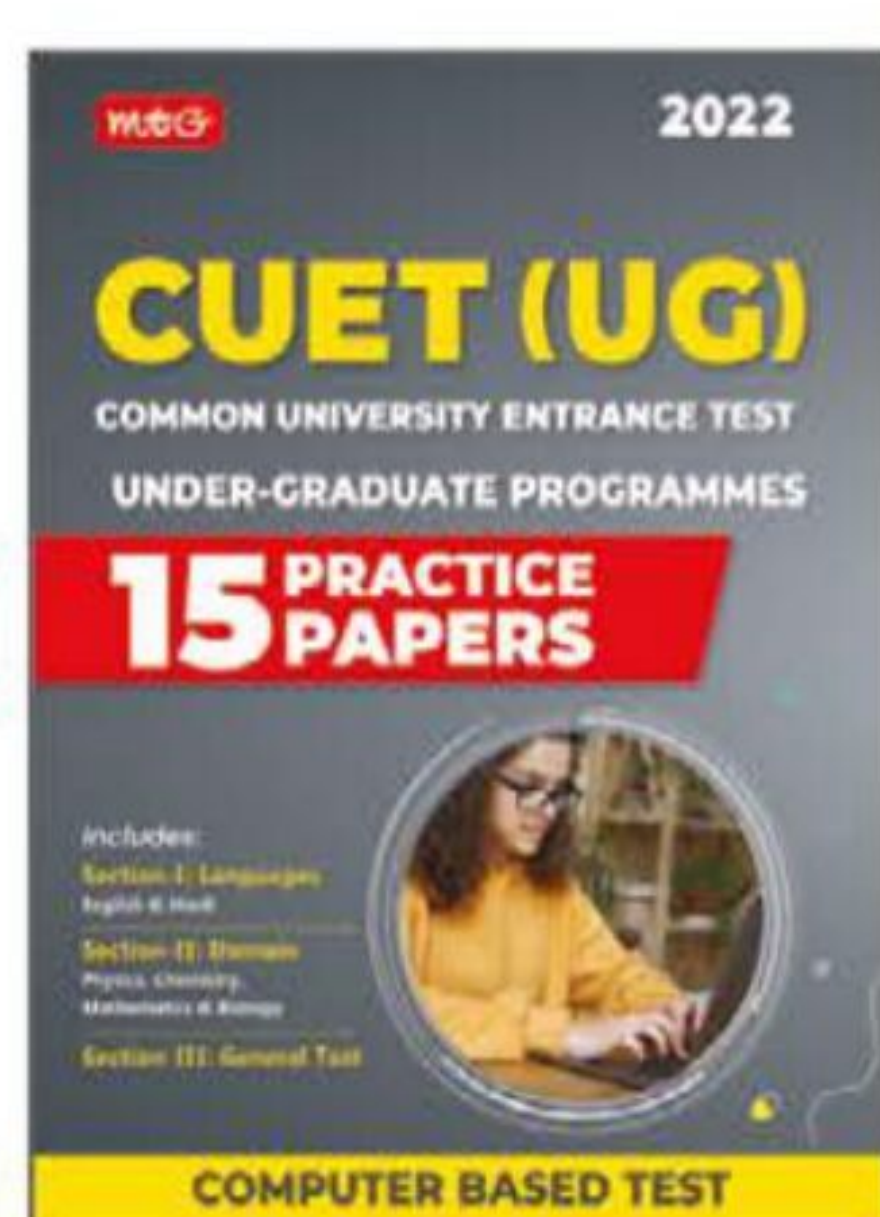
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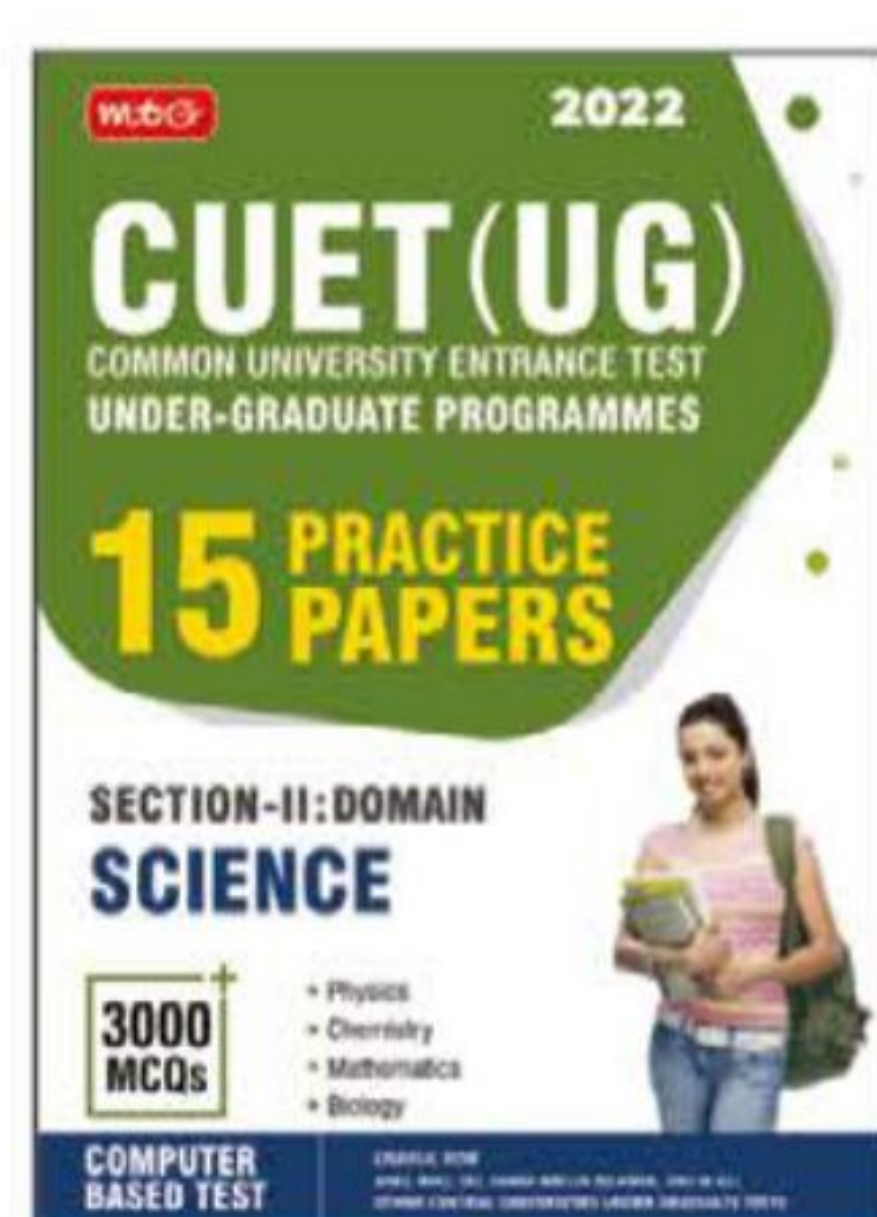
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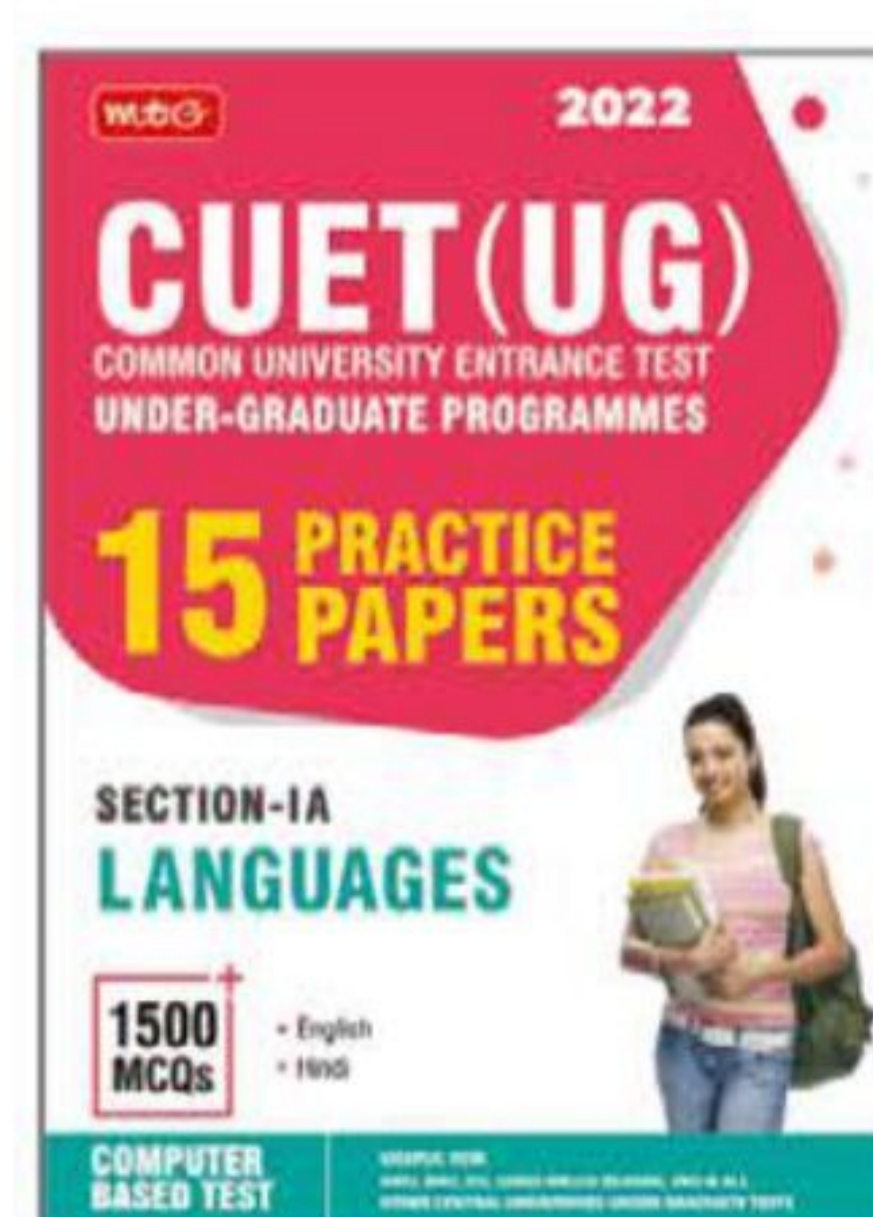
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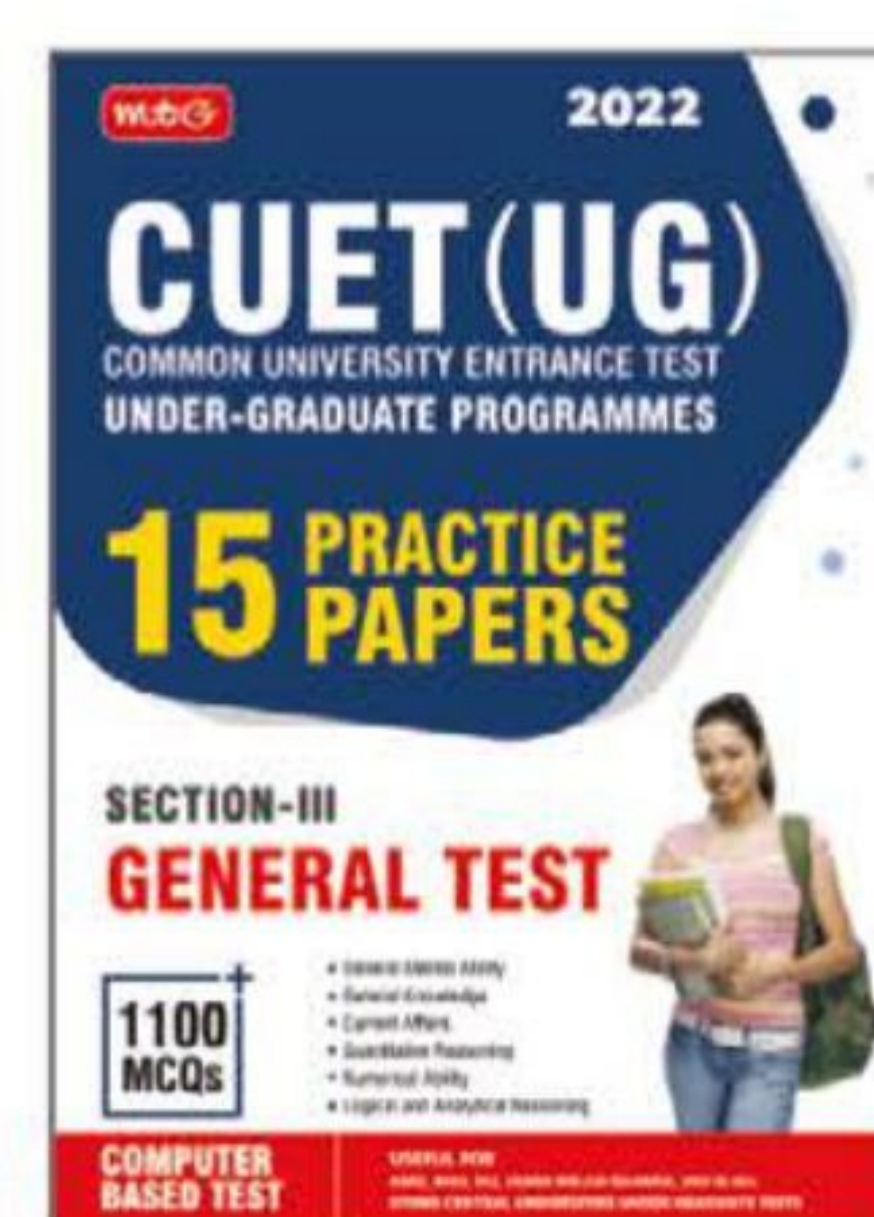
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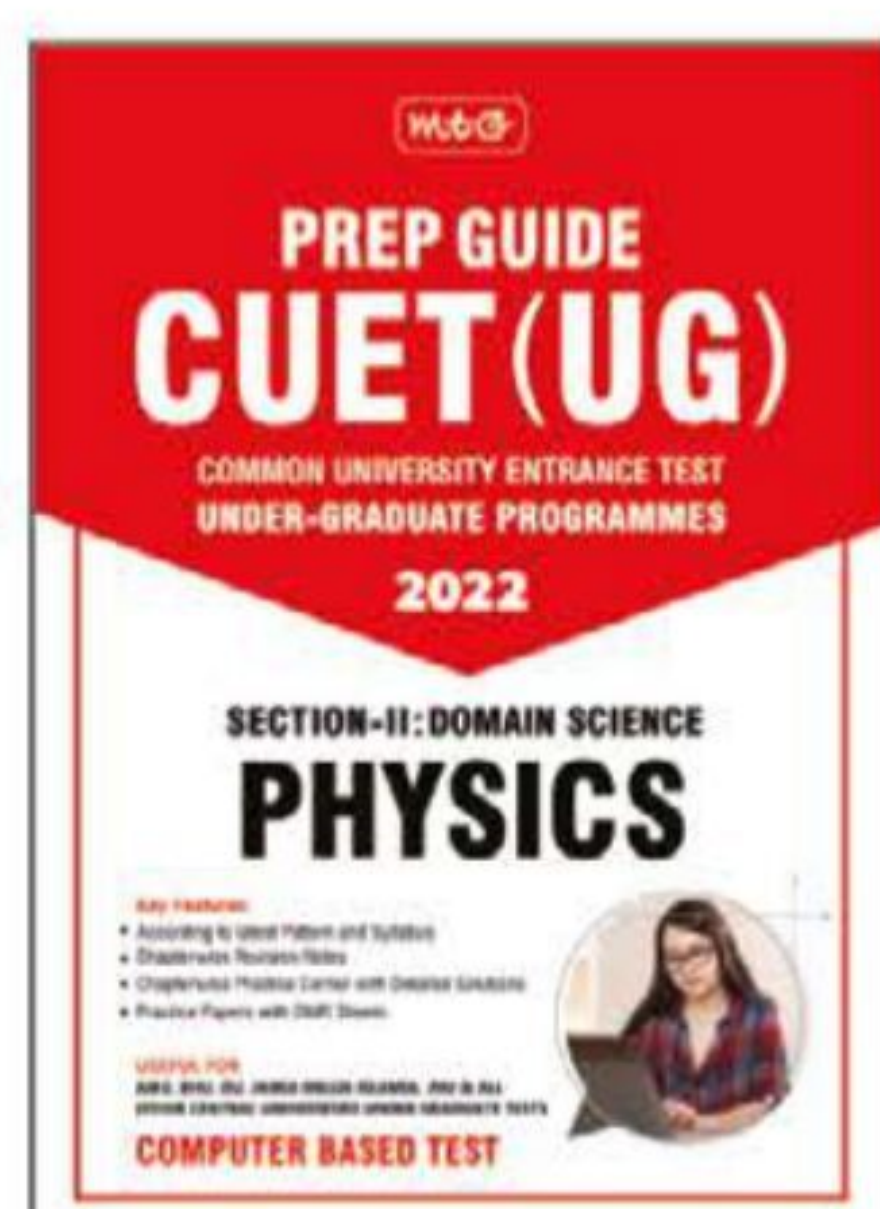


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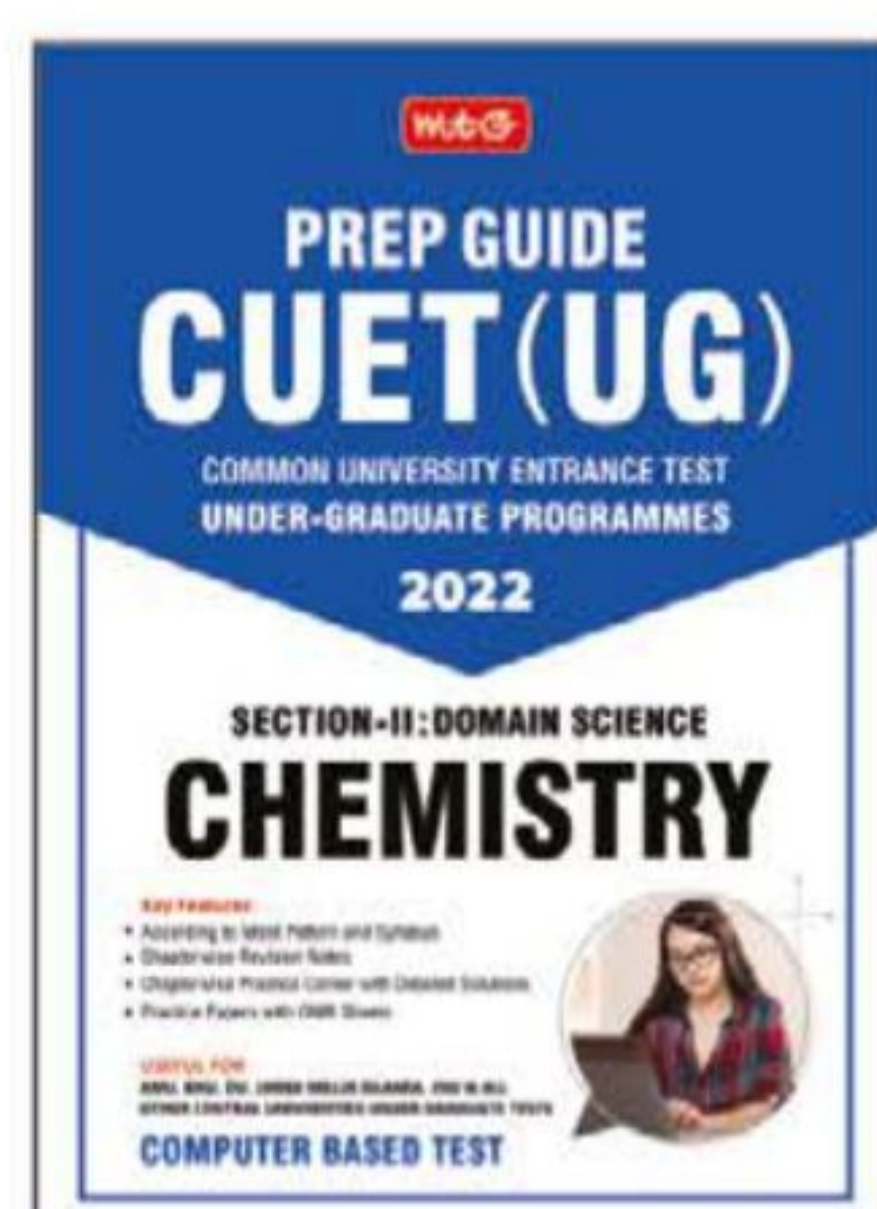
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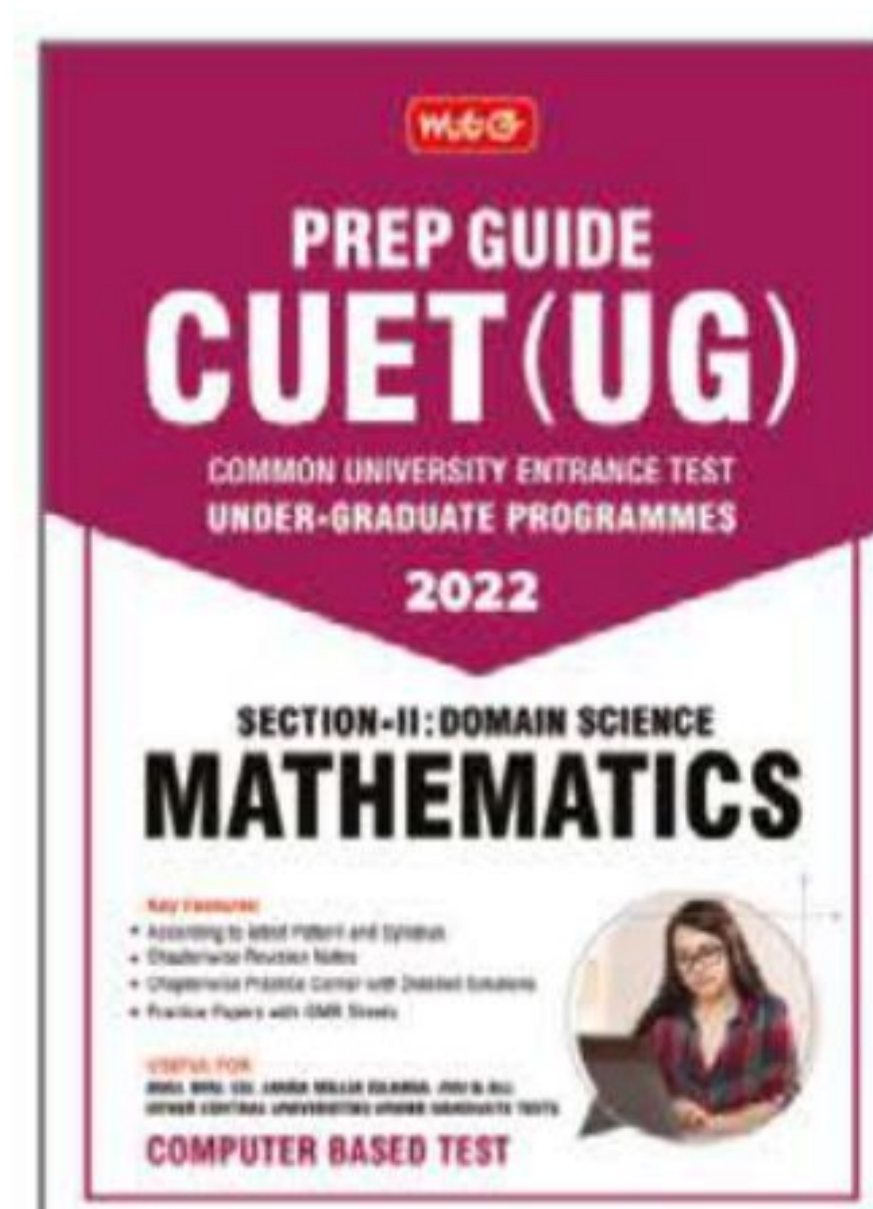
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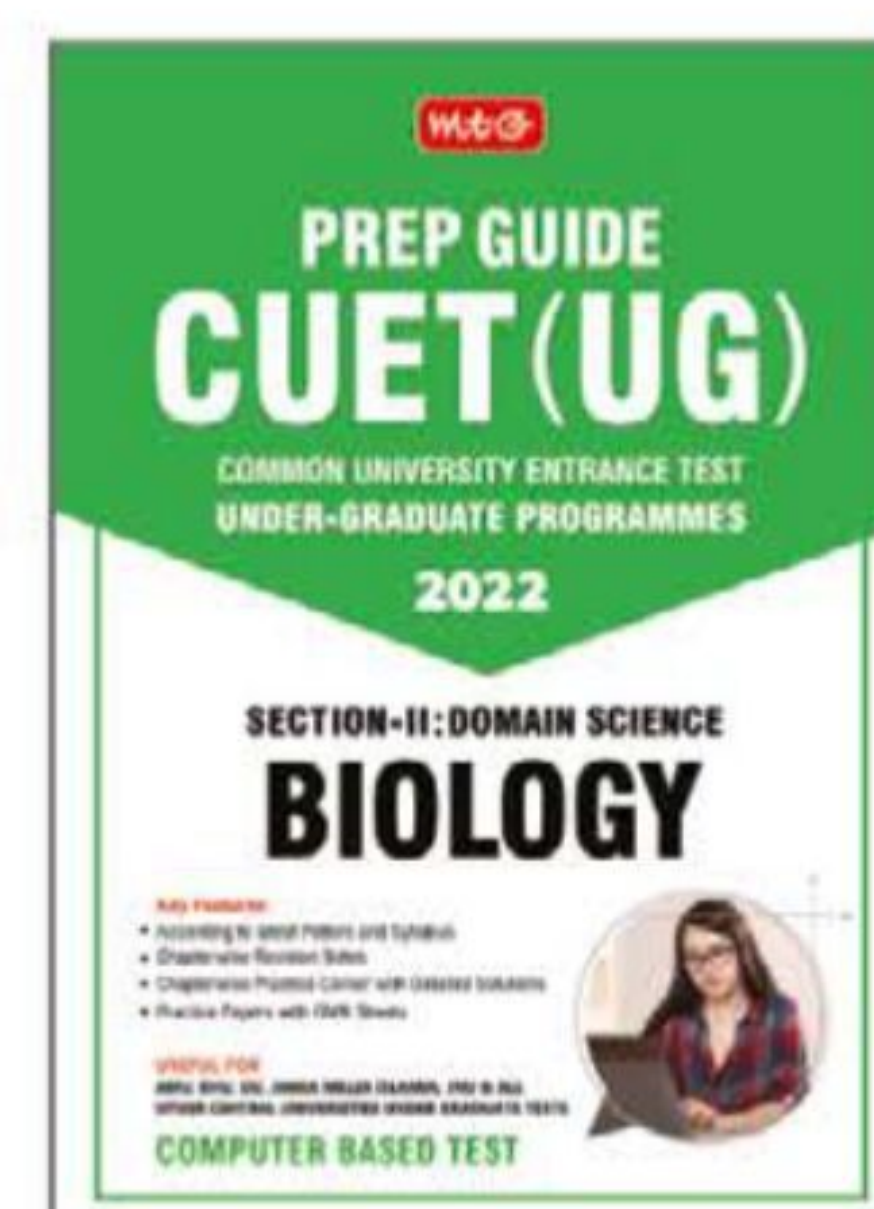
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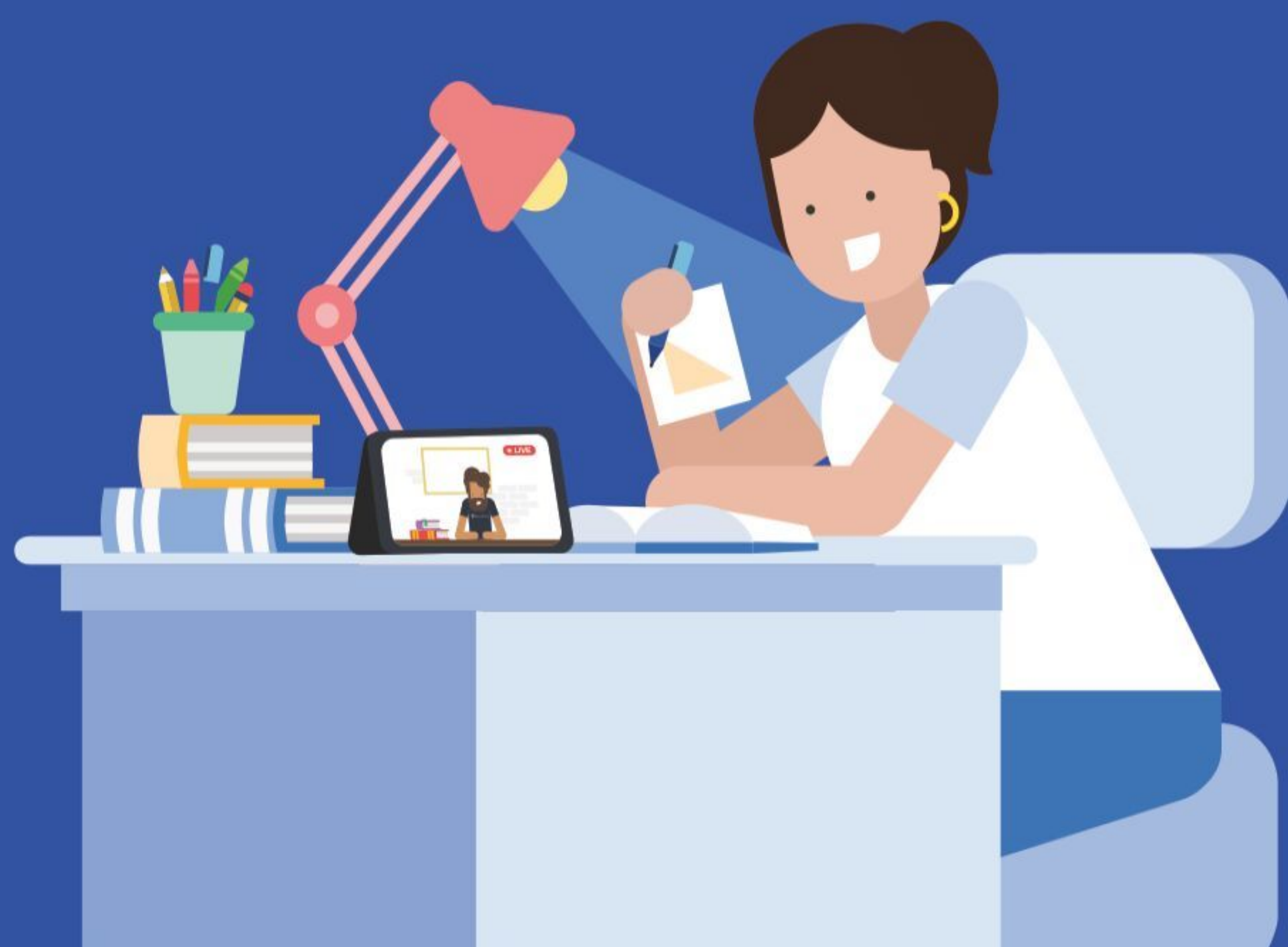
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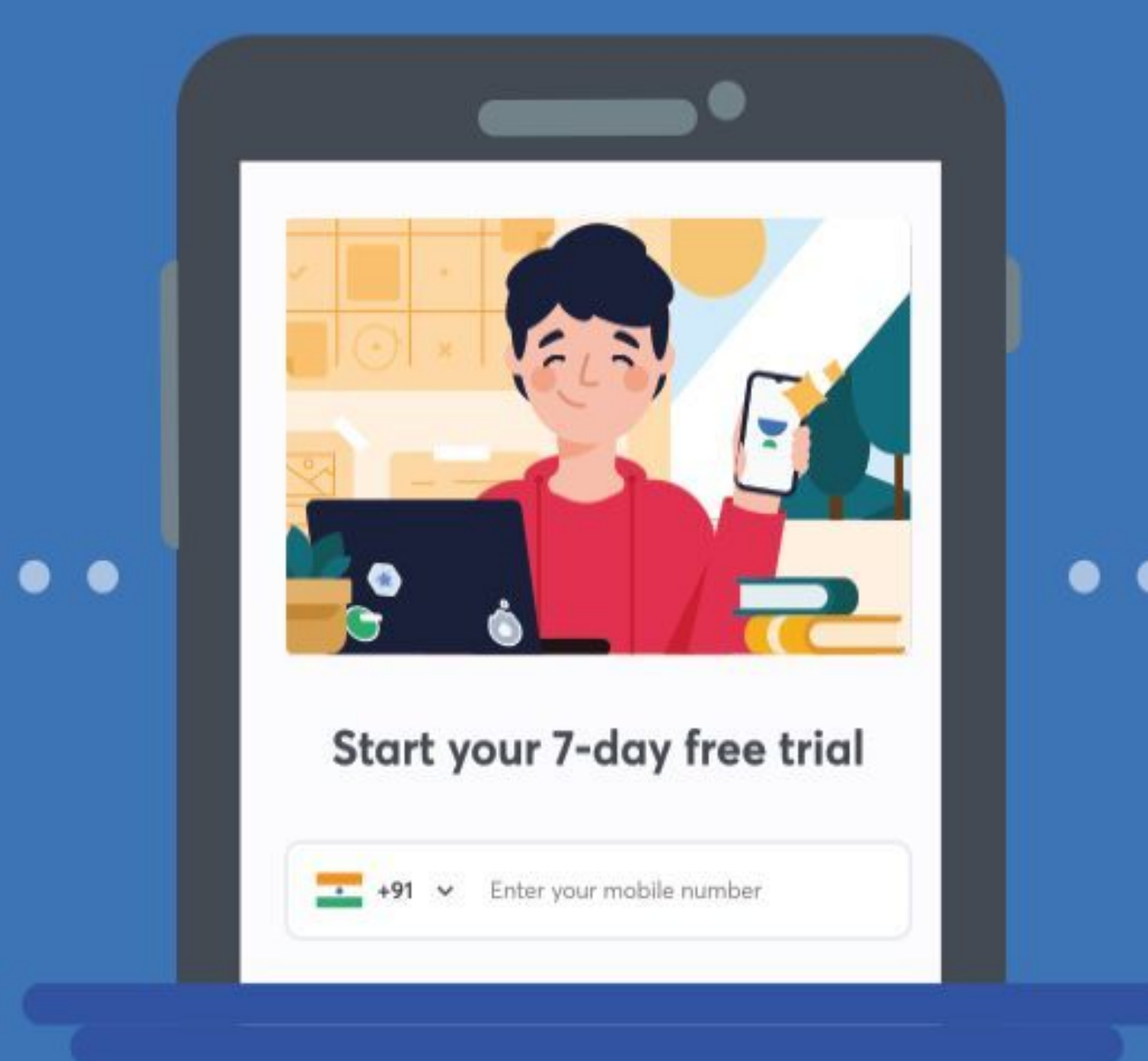
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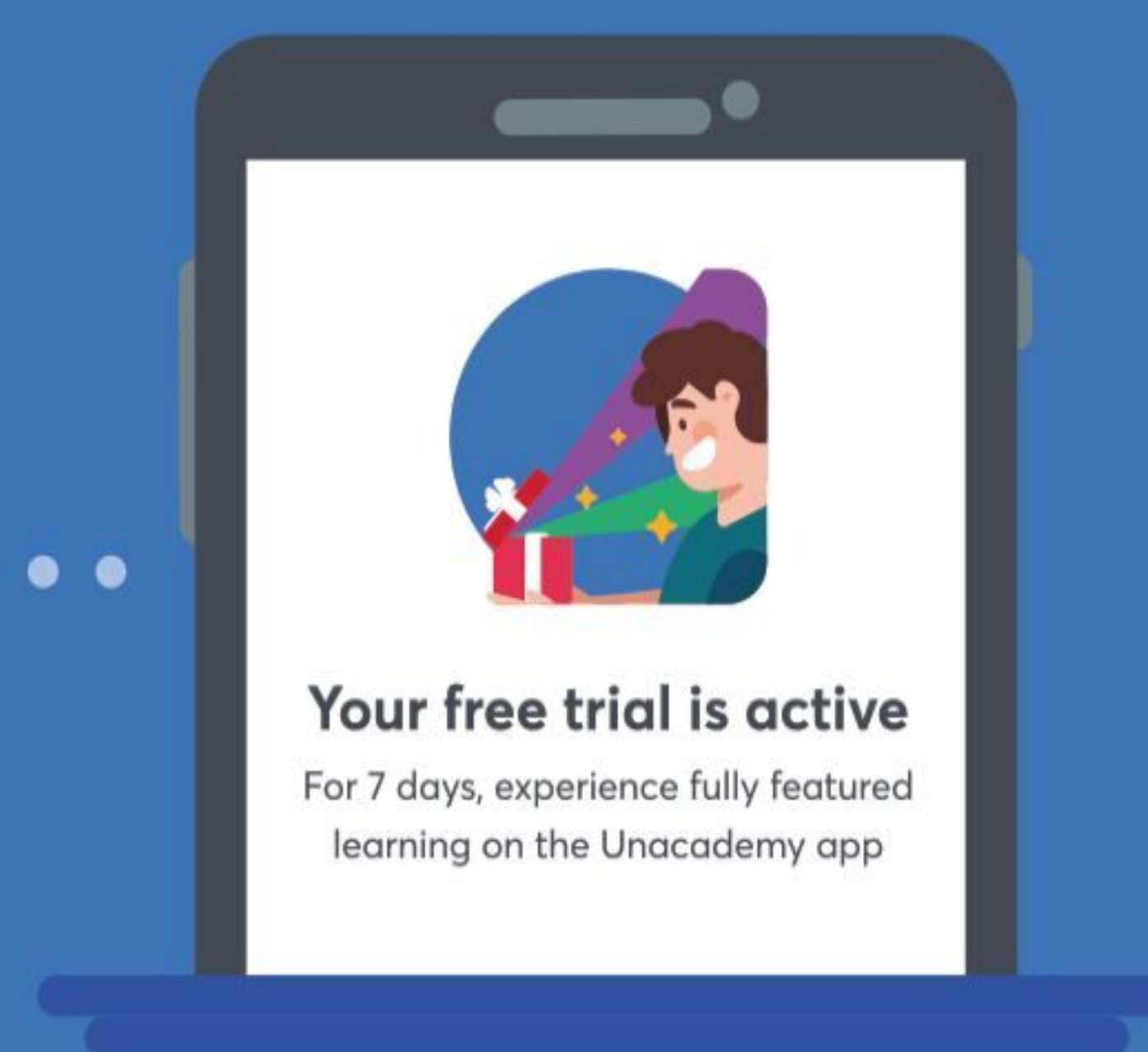
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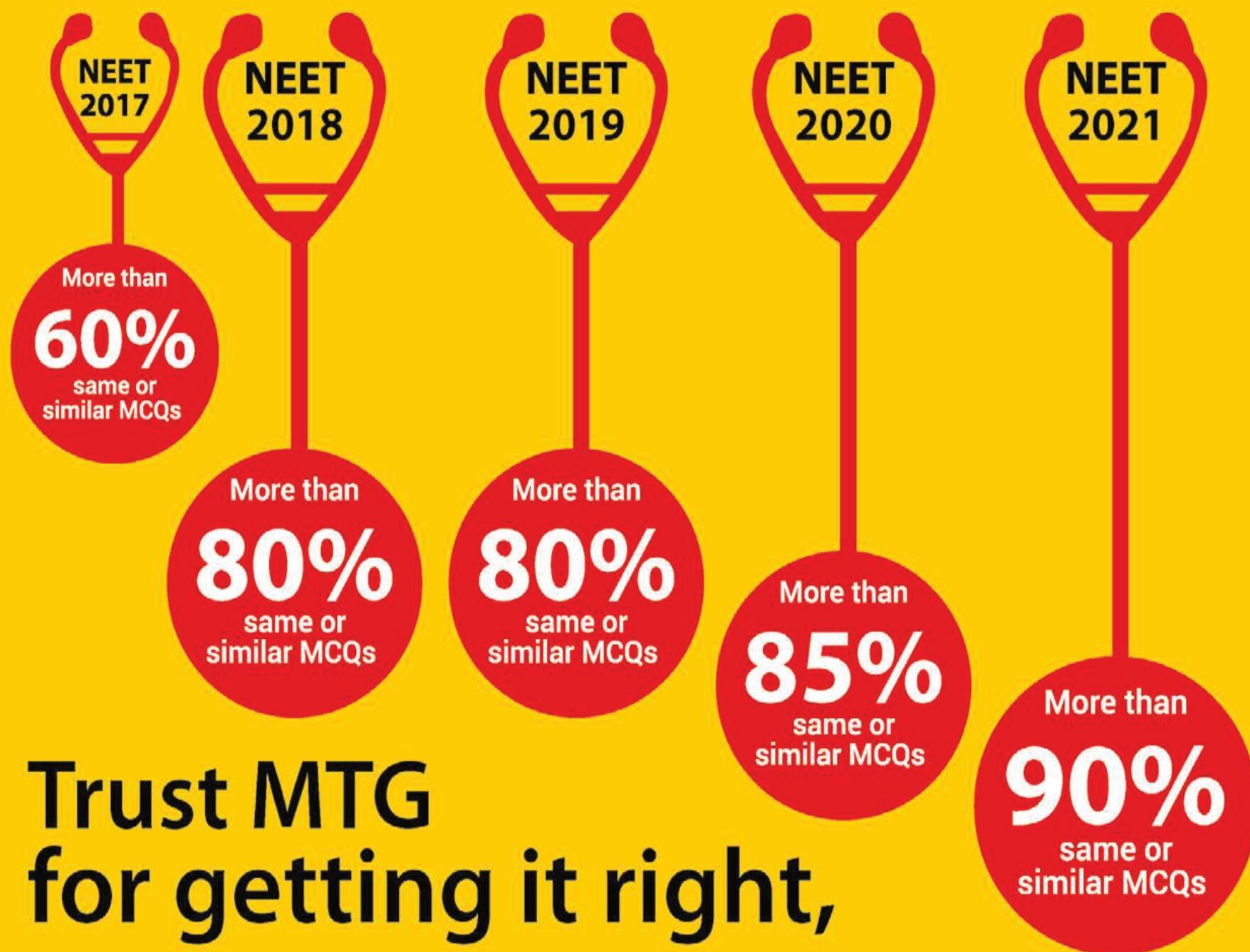


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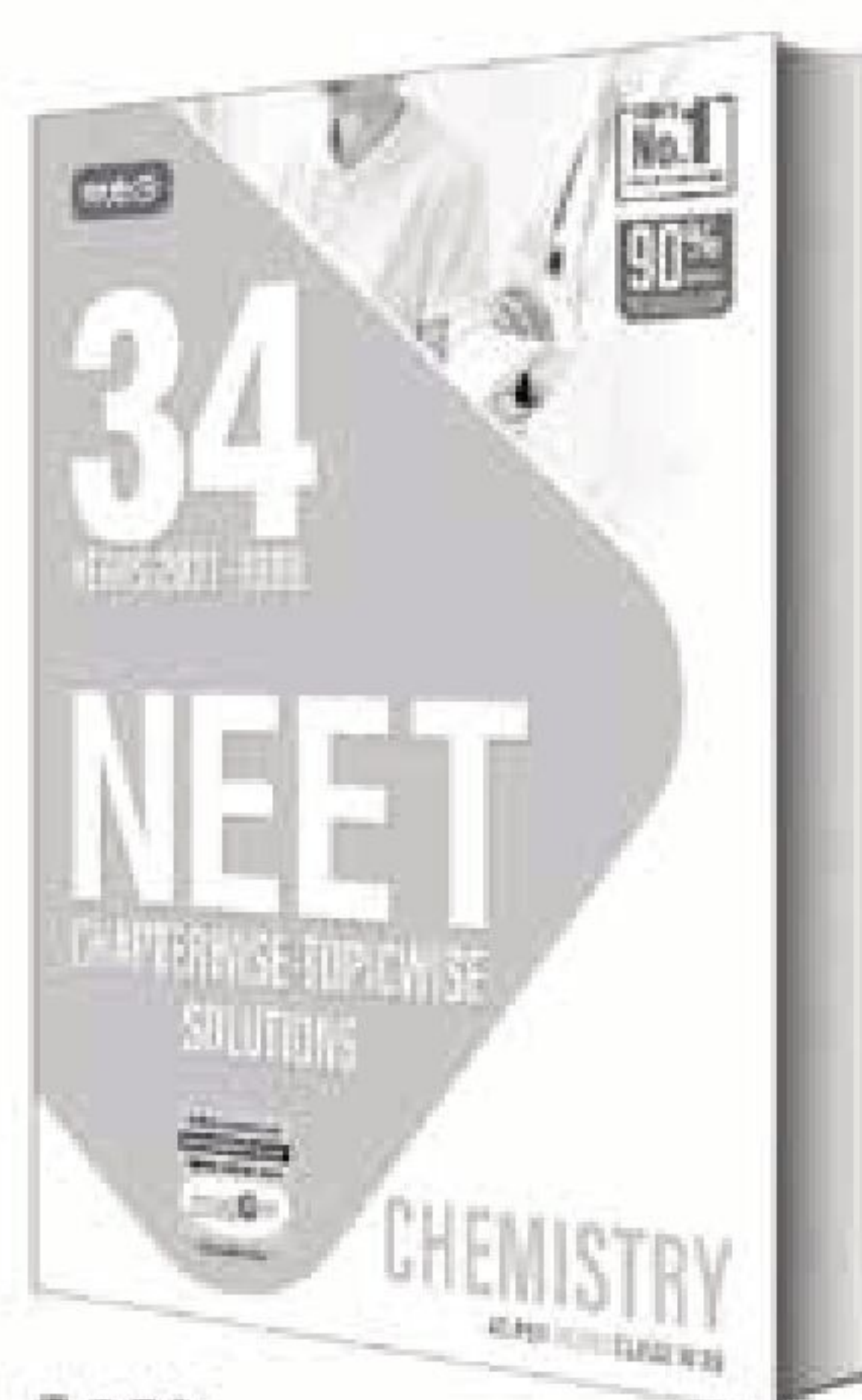
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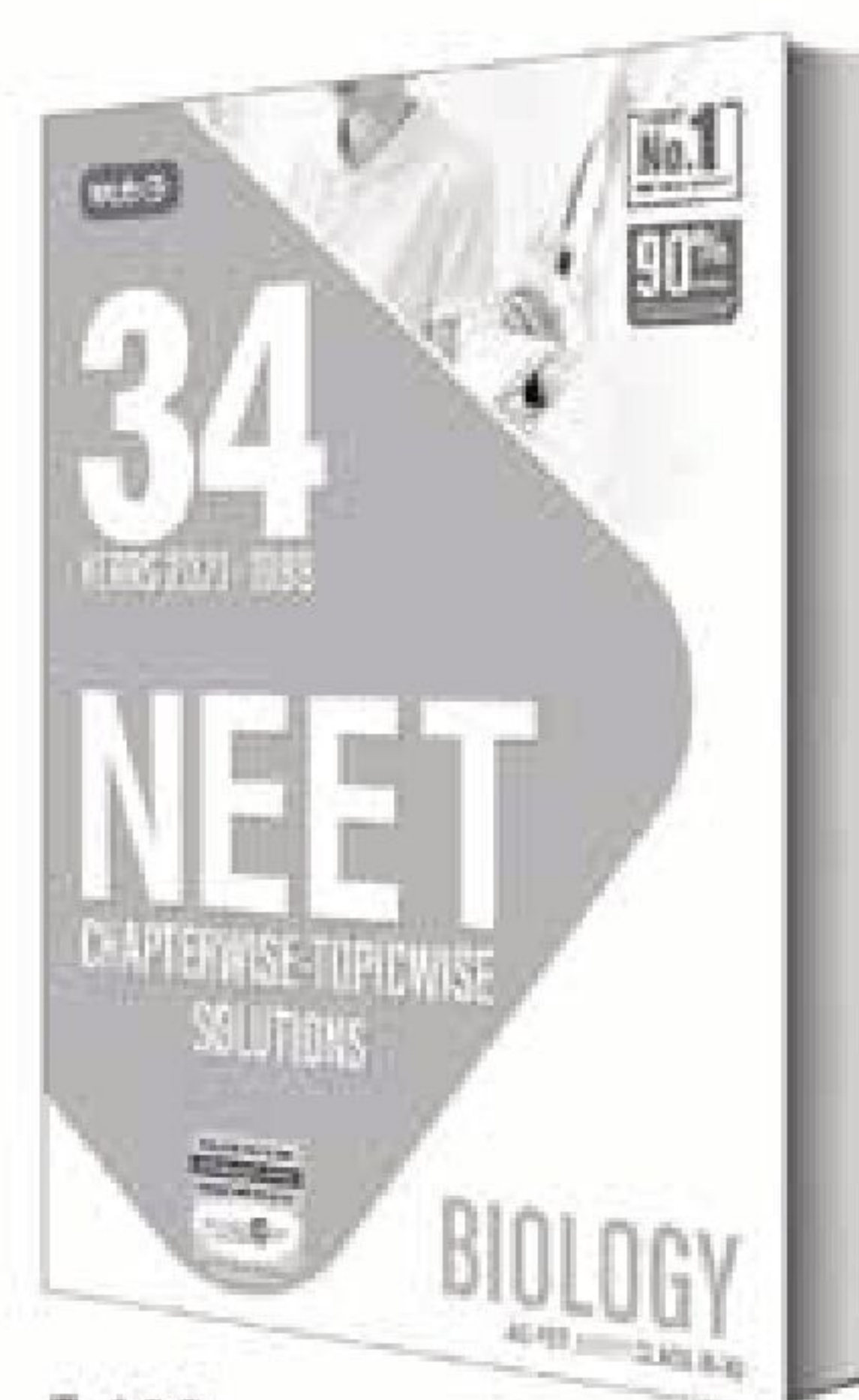
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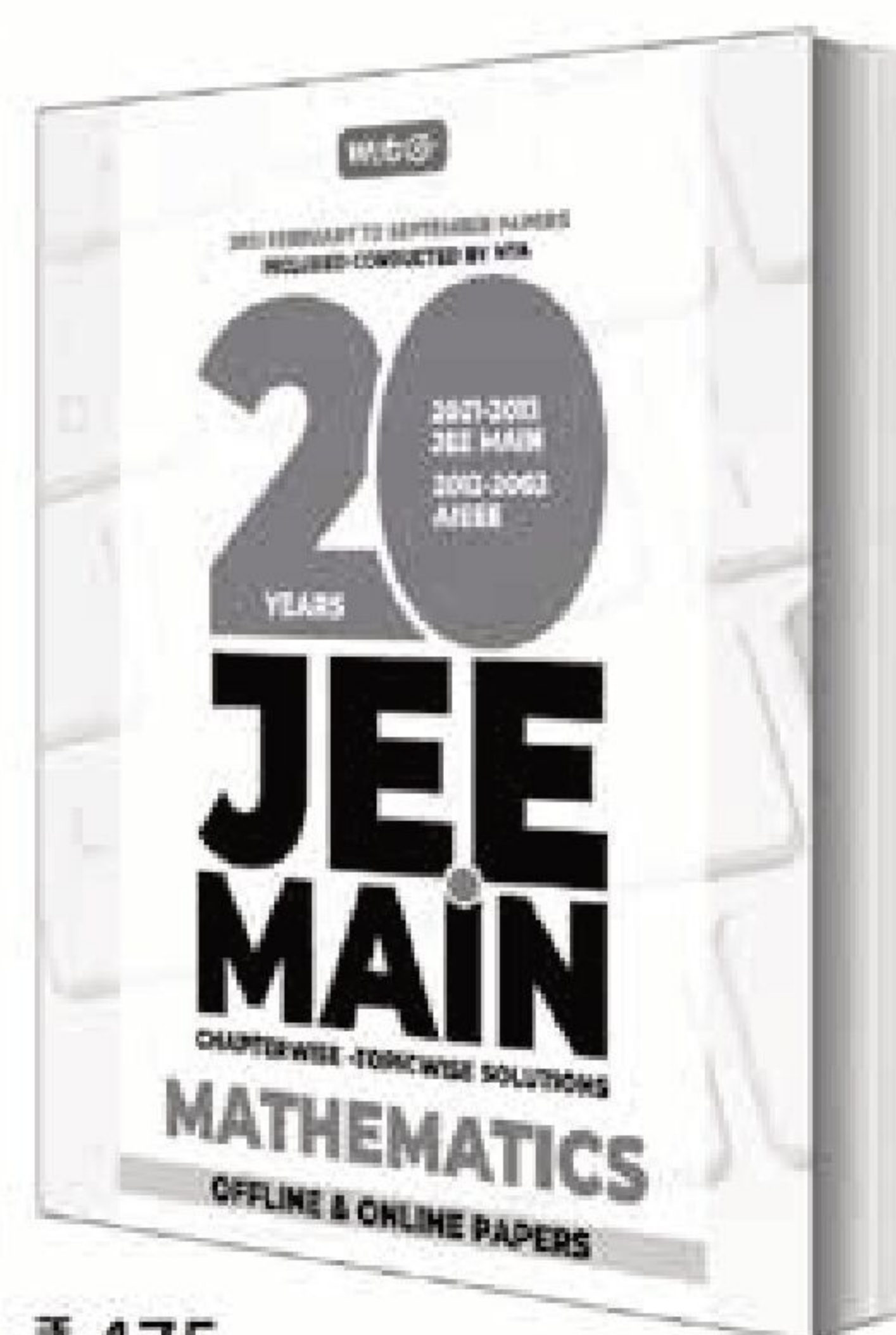
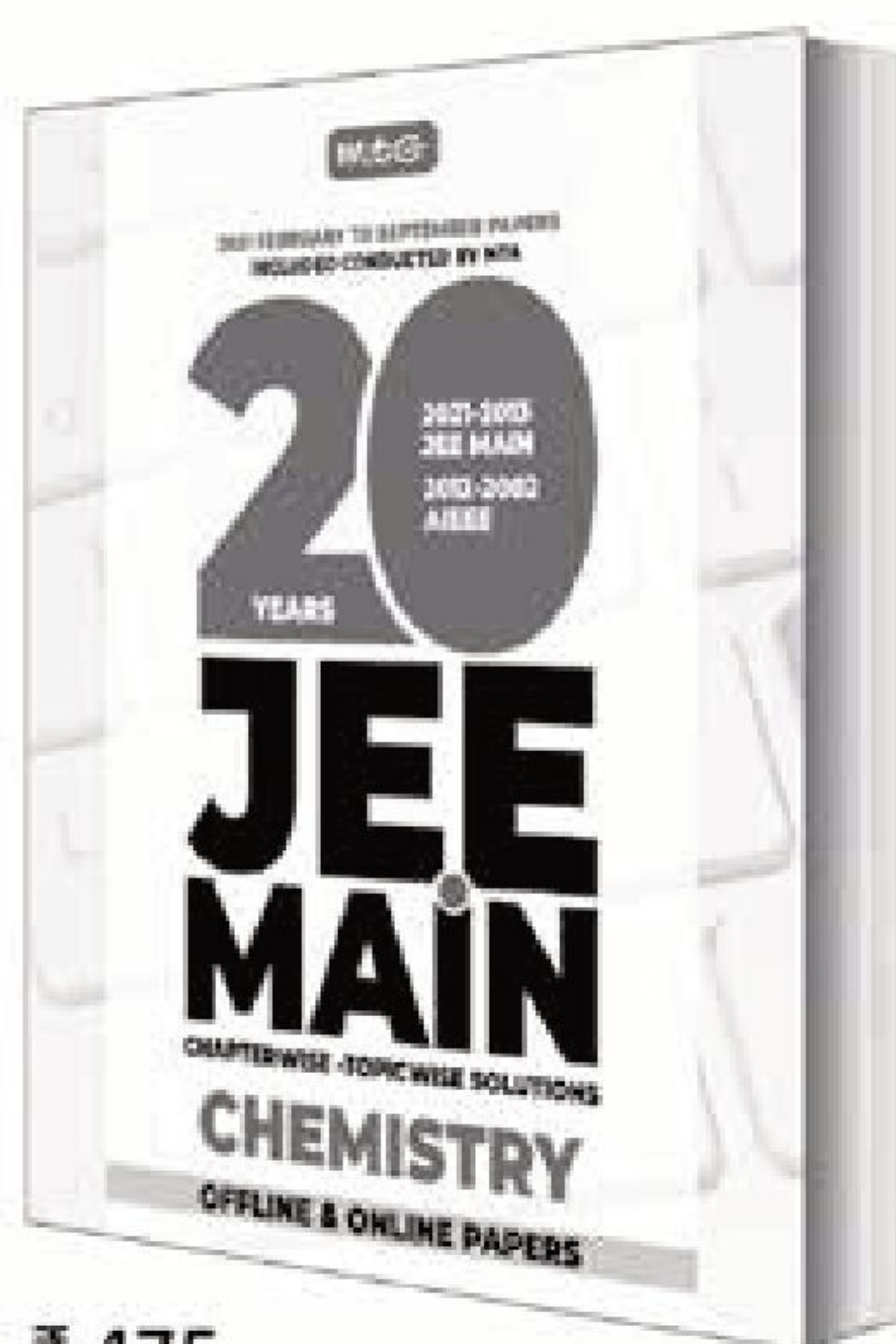
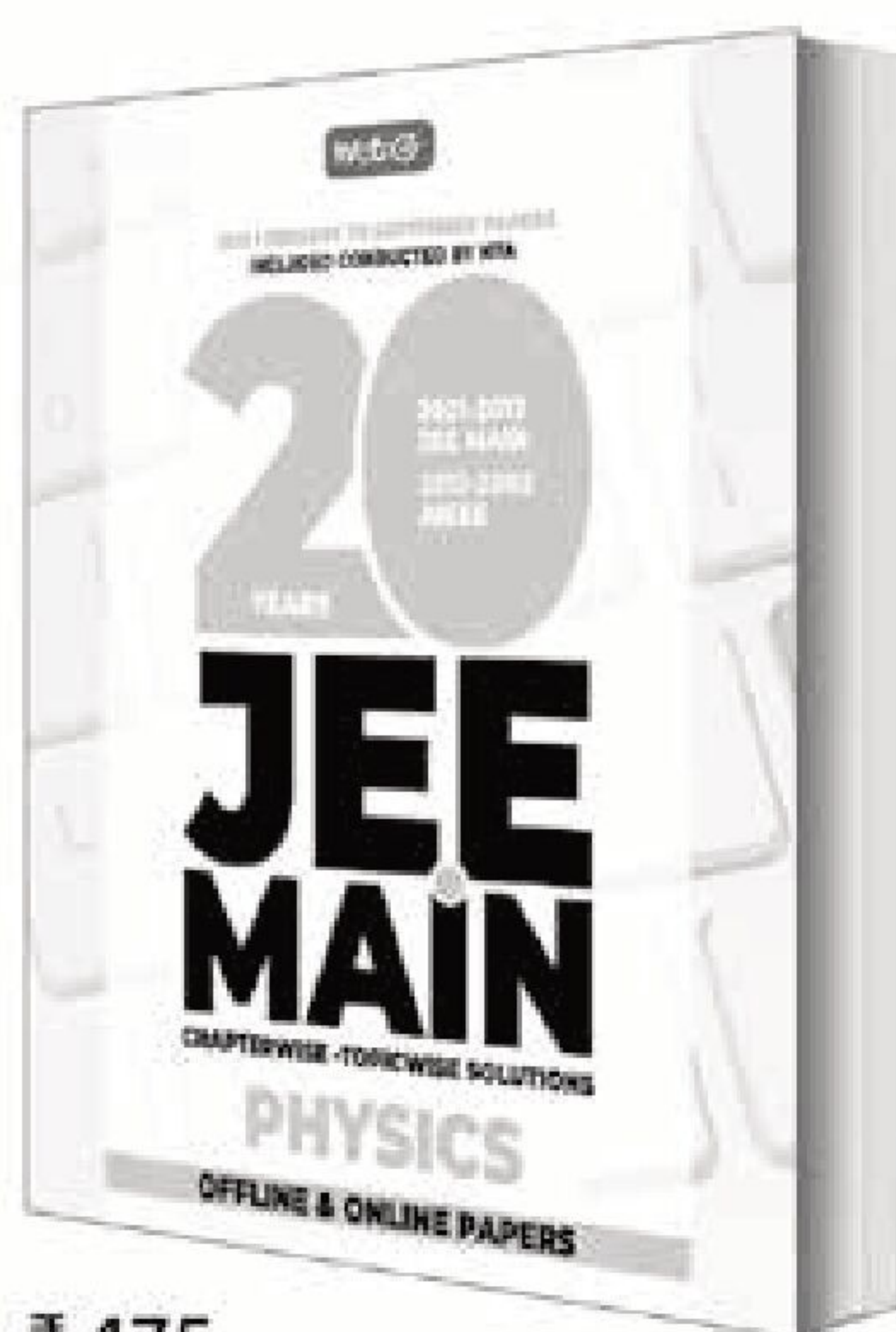
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PRACTICE PAPER 2022 JEE MAIN

Exam Dates

Session-1

23rd to 29th June

Session-2

21st to 30th July

SECTION - A (MULTIPLE CHOICE QUESTIONS)

1. How many moles of ferric alum $(\text{NH}_4)_2\text{SO}_4 \cdot \text{Fe}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$ can be made from the sample of Fe containing 0.0056 g of it?

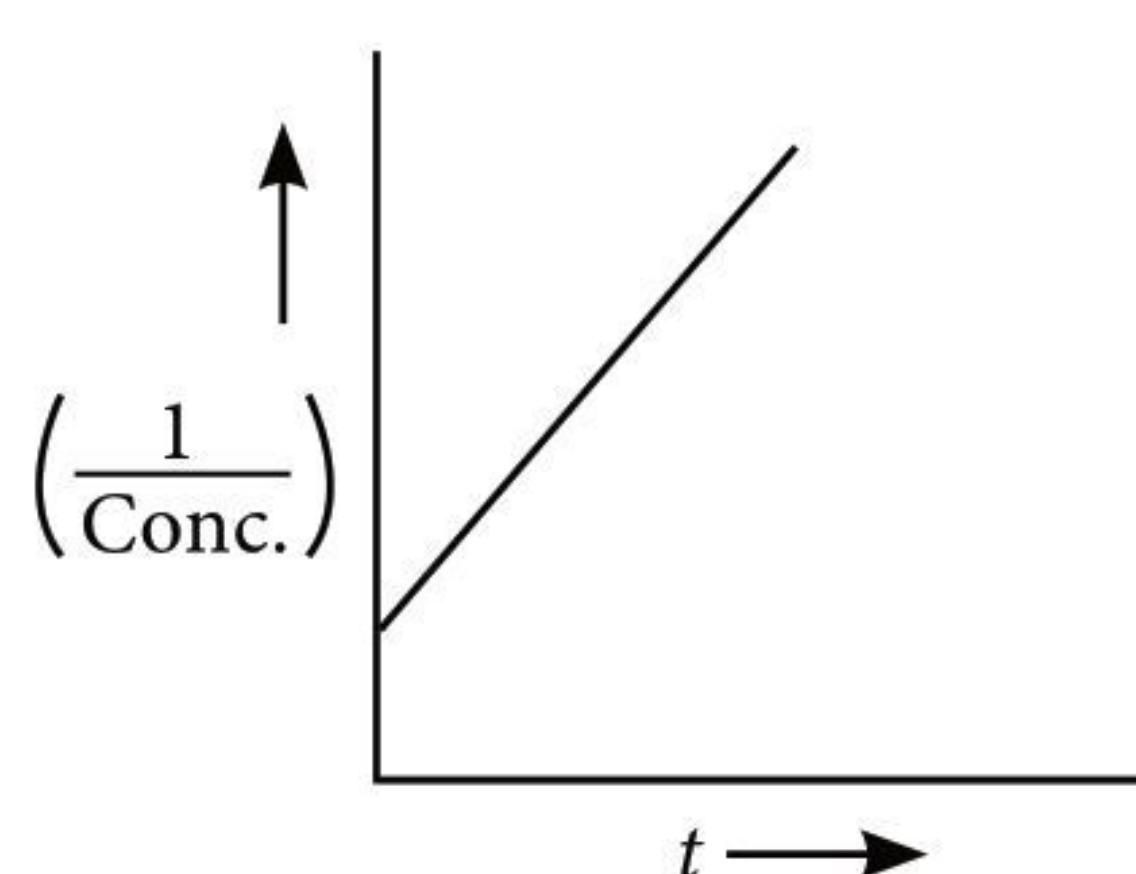
(a) 10^{-4} mol (b) 0.5×10^{-4} mol
(c) 0.33×10^{-4} mol (d) 2×10^{-4} mol

2. $a\text{K}_2\text{Cr}_2\text{O}_7 + b\text{KCl} + c\text{H}_2\text{SO}_4 \longrightarrow x\text{CrO}_2\text{Cl}_2 + y\text{KHSO}_4 + z\text{H}_2\text{O}$

The above equation balances when

(a) $a = 2, b = 4, c = 6$ and $x = 2, y = 6, z = 3$
(b) $a = 4, b = 2, c = 6$ and $x = 6, y = 2, z = 3$
(c) $a = 6, b = 4, c = 2$ and $x = 6, y = 3, z = 2$
(d) $a = 1, b = 4, c = 6$ and $x = 2, y = 6, z = 3$

3. In the decomposition of N_2O_5 , the plot between the reciprocal of concentration of the reactant and the time was found to be linear as shown in the figure.

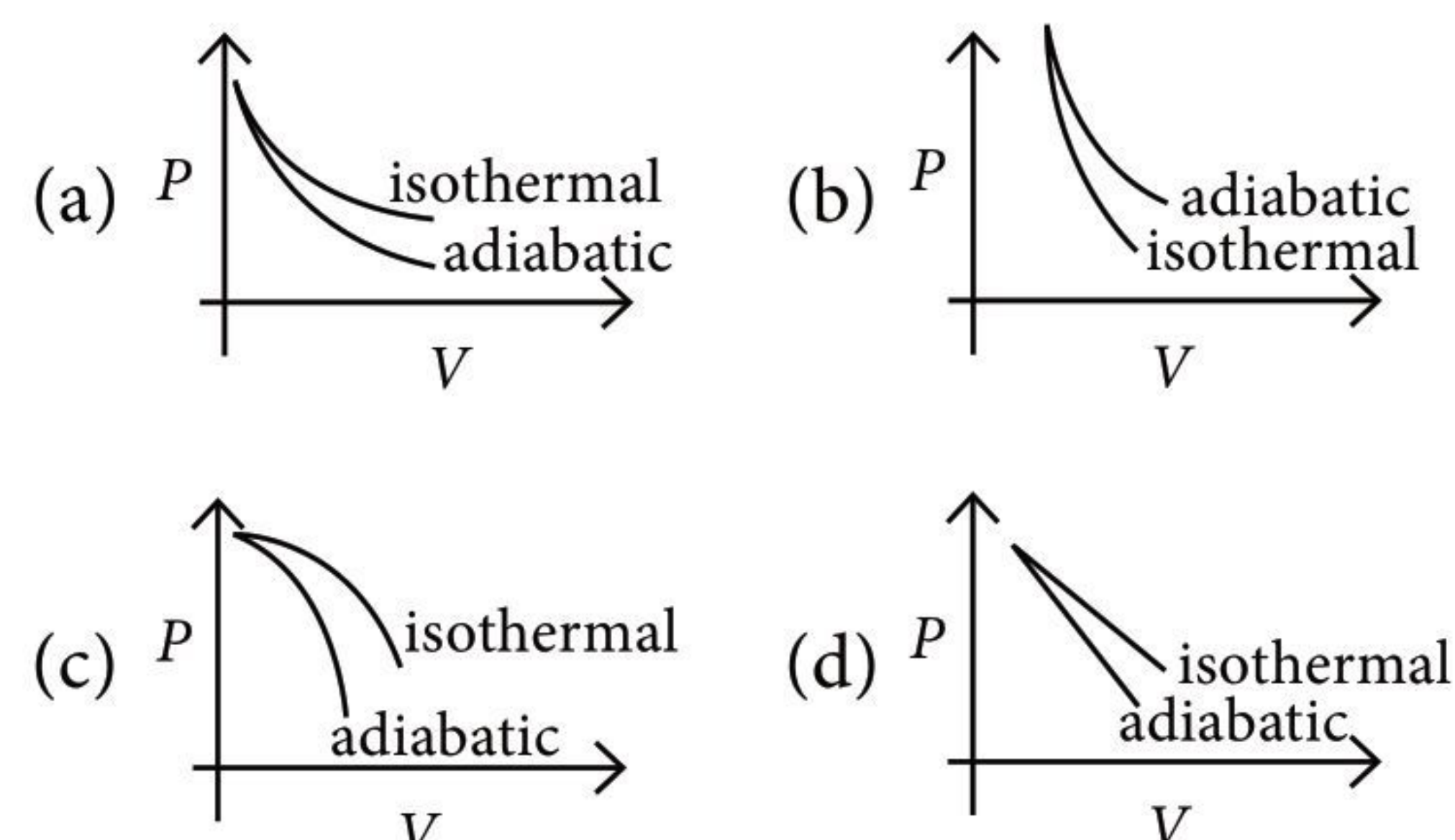


Determine the order of reaction.

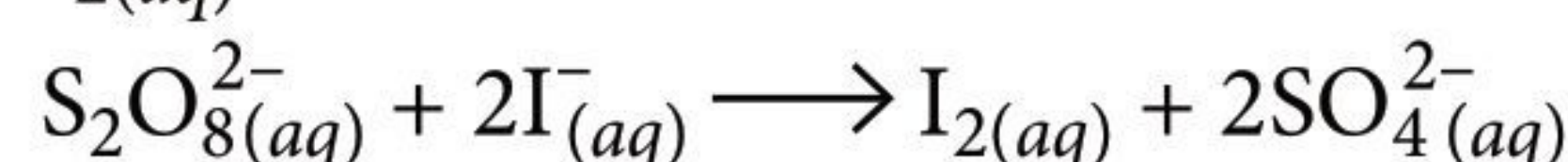
- (a) First (b) Second
(c) Zero (d) None of these
4. Which one among the following will show the tautomerism?

(a) $\text{C}_6\text{H}_5-\overset{\text{O}}{\parallel}{\text{C}}-\text{C}_6\text{H}_5$ (b) $\text{C}_6\text{H}_5-\text{CH}=\text{O}$
(c) $\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$ (d) $\text{C}_6\text{H}_5-\overset{\text{O}}{\parallel}{\text{C}}-\text{C}(\text{CH}_3)_3$

5. The correct figure representing isothermal and adiabatic expansions of an ideal gas from a particular initial state is



6. The times listed are those recorded at 25° C for the reaction below to produce a measurable amount of $\text{I}_{2(aq)}$:



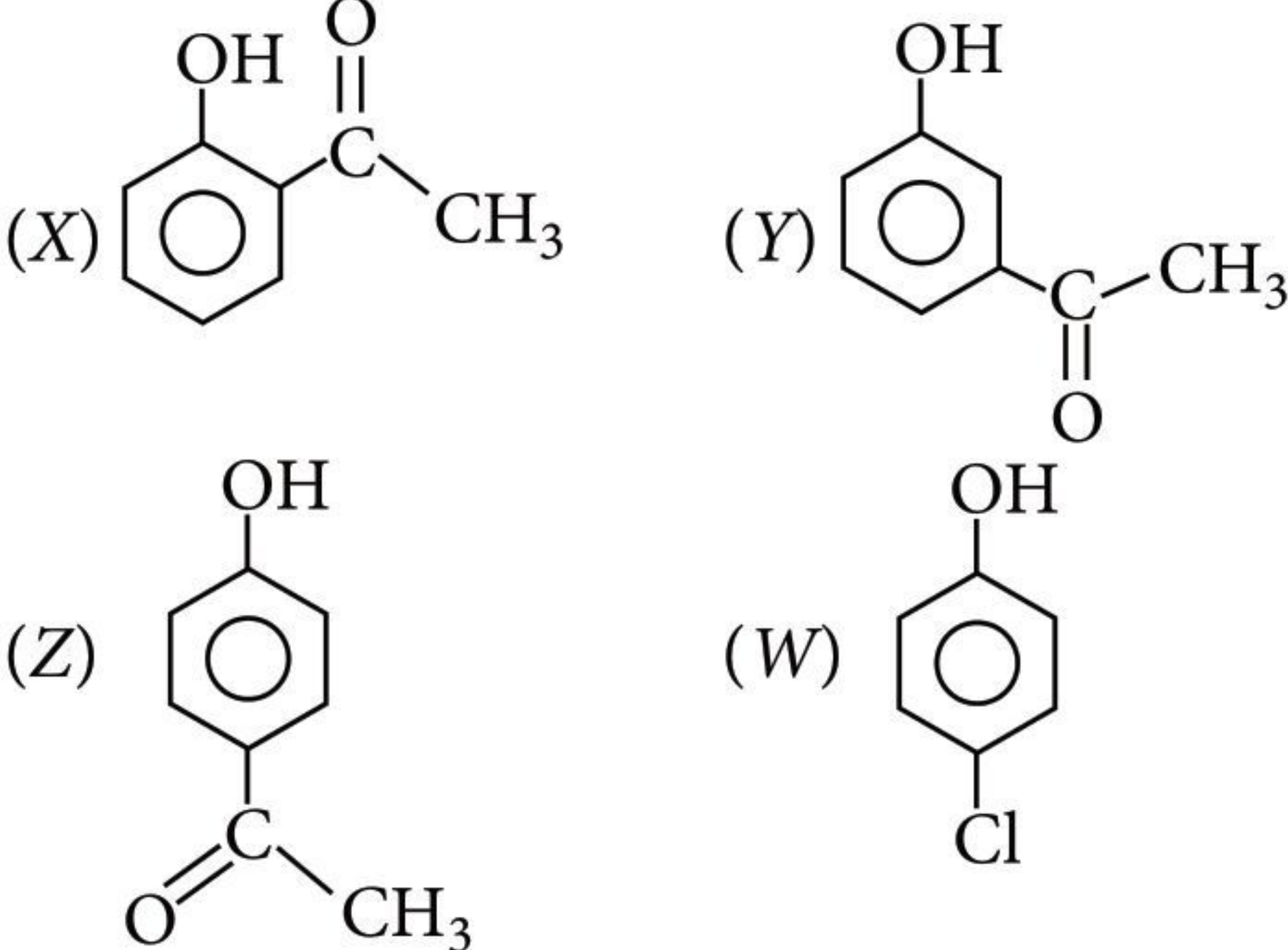
Exp.	Initial (M) $[\text{S}_2\text{O}_8^{2-}]$	Initial (M) $[\text{I}^-]$	Time (sec)
1.	0.0400	0.0800	39
2.	0.0400	0.0400	78
3.	0.0100	0.0800	156
4.	0.0200	0.0200	?

What is the expected time for experiment 4?

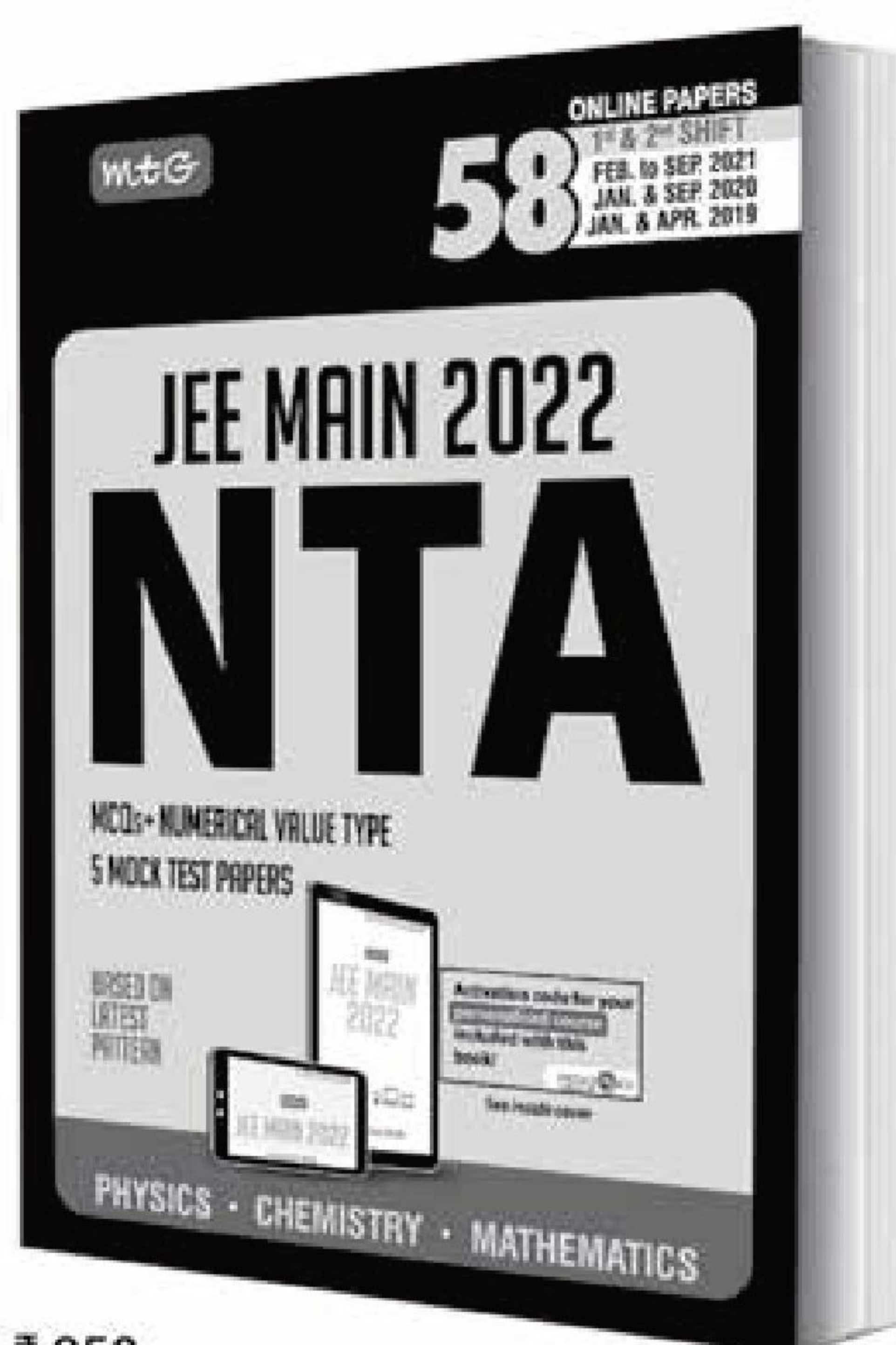
- (a) 156 sec (b) 234 sec (c) 312 sec (d) 624 sec
7. The products expected to be formed in the Wurtz reaction of a mixture of neopentyl bromide and isobutyl bromide are
- (i) 2,2,4-trimethylpentane
(ii) 2,2,5,5-tetramethylhexane
(iii) 2,2,4,4-tetramethylhexane
(iv) 2,5-dimethylhexane
(v) 2,2,5-Trimethylhexane
- (a) (ii), (iii) and (v) (b) (ii), (iv) and (v)
(c) (i), (iv) and (v) (d) (i), (iii) and (v)
8. Identify the correct statement regarding enzymes.
- (a) Enzymes are specific biological catalysts that can normally function at very high temperatures ($T \sim 1000$ K).

- (b) Enzymes are normally heterogeneous catalysts that are very specific in action.
 (c) Enzymes are specific biological catalysts that cannot be poisoned.
 (d) Enzymes are specific biological catalysts that possess well-defined active sites.
9. Which of the following options is incorrect?
 (a) pH at half equivalent point of a weak acid (HA) is equal to pK_b of its conjugate base.
 (b) An aqueous solution of sodium acetate will be basic due to anionic hydrolysis.
 (c) On dilution of a solution of a weak acid, degree of ionisation will increase but $[H^+]$ will decrease.
 (d) All of these.
10. The final product B in the following reaction is

$$CH_3CH_2CH=CH_2 \xrightarrow[(C_6H_5CO_2)_2]{NBS, h\nu} A \xrightarrow[CH_3OH]{CH_3SNa} B$$

 (a) 3-methylsulphanylbut-1-ene
 (b) allyl methyl sulphide
 (c) *n*-butyl methyl sulphide
 (d) diallyl sulphide.
11. Which of the following expressions correctly represents the relationship between the average molecular kinetic energies (\overline{KE}) of CO and N_2 molecules at the same temperature?
 (a) $\overline{KE}_{CO} = \overline{KE}_{N_2}$ (b) $\overline{KE}_{CO} > \overline{KE}_{N_2}$
 (c) $\overline{KE}_{CO} < \overline{KE}_{N_2}$ (d) All of the above
12. The BCl_3 is a planar molecule whereas NCl_3 is pyramidal because
 (a) N—Cl bond is more covalent than B—Cl bond
 (b) B—Cl bond is more polar than N—Cl bond
 (c) nitrogen atom is smaller than boron
 (d) BCl_3 has no lone pair but NCl_3 has a lone pair of electron.
13. The standard reduction potentials of Cu^{2+}/Cu and Cu^{2+}/Cu^+ are 0.337 V and 0.153 V respectively. The standard electrode potential of Cu^+/Cu half cell is
 (a) 0.184 V (b) 0.827 V
 (c) 0.521 V (d) 0.490 V.
14. Which of the following orders of relative strengths of acids is correct?
 (a) $FCH_2COOH > ClCH_2COOH > BrCH_2COOH$
 (b) $ClCH_2COOH > BrCH_2COOH > FCH_2COOH$
 (c) $BrCH_2COOH > ClCH_2COOH > FCH_2COOH$
 (d) $ClCH_2CO_2H > FCH_2COOH > BrCH_2COOH$
15. The standard heat of combustion of Al is $-837.8 \text{ kJ mol}^{-1}$ at 25°C . If Al reacts with O_2 at 25°C , which of the following will release 250 kJ of heat?
 (a) The reaction of 0.624 mole of Al.
 (b) The formation of 0.624 mole of Al_2O_3 .
 (c) The reaction of 0.313 mol of Al.
 (d) The formation of 0.150 mol of Al_2O_3 .
16. Which of the following statements is not correct?
 (a) $La(OH)_3$ is less basic than $Lu(OH)_3$.
 (b) In lanthanide series ionic radius of Ln^{3+} ions decreases.
 (c) La is actually an element of transition series rather than lanthanide series.
 (d) Atomic radii of Zr and Hf are same because of lanthanide contraction.
17. If equal volumes of $BaCl_2$ and NaF solutions are mixed, which of these combination will give a precipitate?
 (K_{sp} of $BaF_2 = 1.7 \times 10^{-7}$).
 (a) $10^{-3} \text{ M } BaCl_2$ and $2 \times 10^{-2} \text{ M NaF}$
 (b) $10^{-3} \text{ M } BaCl_2$ and $1.5 \times 10^{-2} \text{ M NaF}$
 (c) $1.5 \times 10^{-3} \text{ M } BaCl_2$ and 10^{-2} M NaF
 (d) $2 \times 10^{-2} \text{ M } BaCl_2$ and $2 \times 10^{-2} \text{ M NaF}$
18. The correct acidic strength order is

 (a) $X > Z > W > Y$ (b) $Z > X > Y > W$
 (c) $W > Z > X > Y$ (d) $X > Z > Y > W$
19. 1 mol of N_2 is mixed with 3 mol of H_2 in a litre container. If 50% of N_2 is converted into ammonia by the reaction $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$, then the total number of moles of gas at the equilibrium are
 (a) 1.5 (b) 4.5 (c) 3.0 (d) 6.0
20. Which of the following statements is correct for the complex $K_4[Fe(CN)_6]$?
 (a) d^2sp^3 hybridised and diamagnetic
 (b) sp^3d^2 hybridised and paramagnetic
 (c) sp^3d^2 hybridised and diamagnetic
 (d) d^2sp^3 hybridised and paramagnetic

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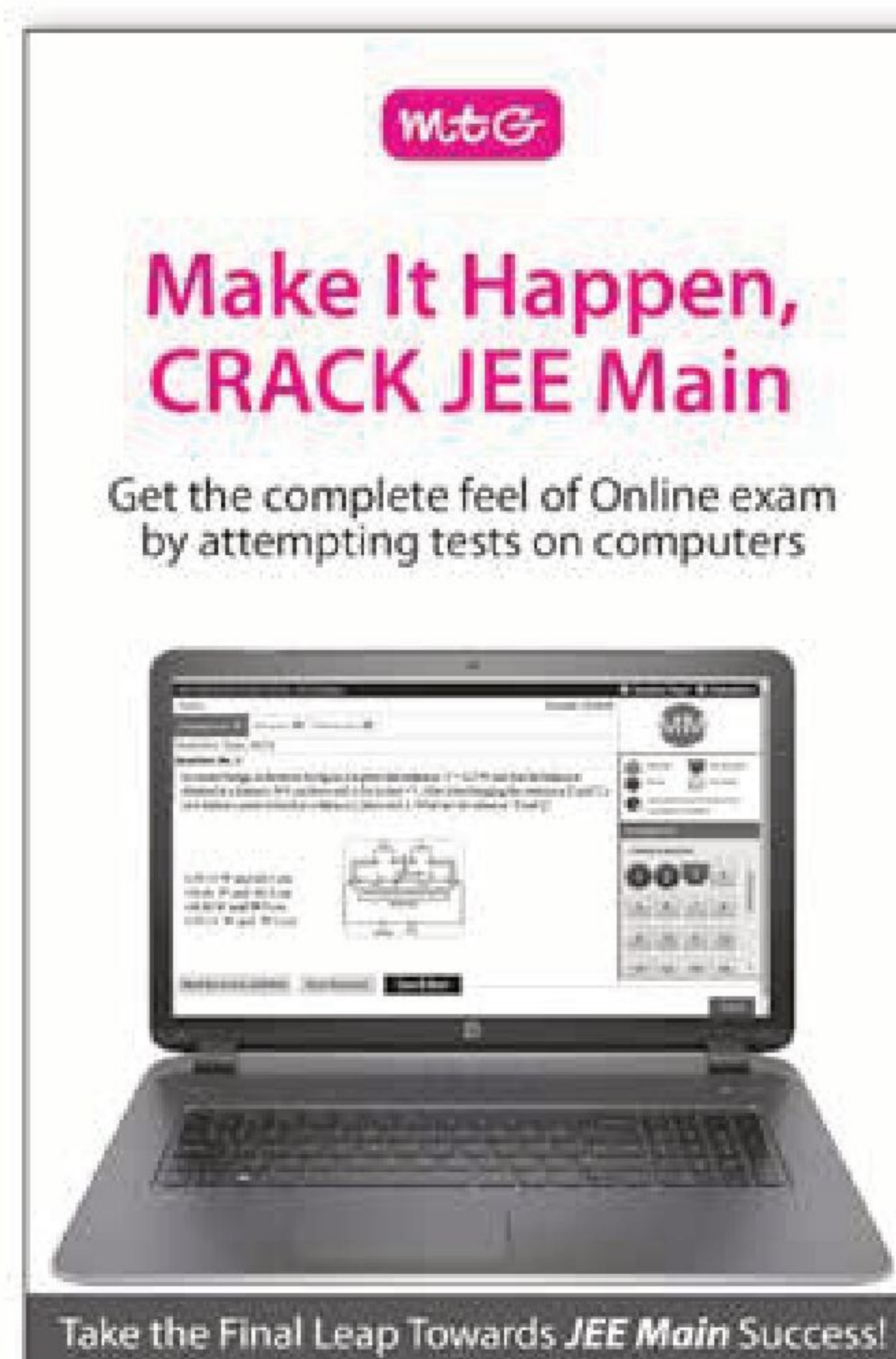
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Highlights

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- 4915 MCQs for Practice
- Chapterwise Tabular and Graphical Analysis Showing the Weightage of Chapters
- 5 MTPs as per the latest JEE Main pattern

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SECTION - B (NUMERICAL TYPE QUESTIONS)

Attempt any 5 questions out of 10.

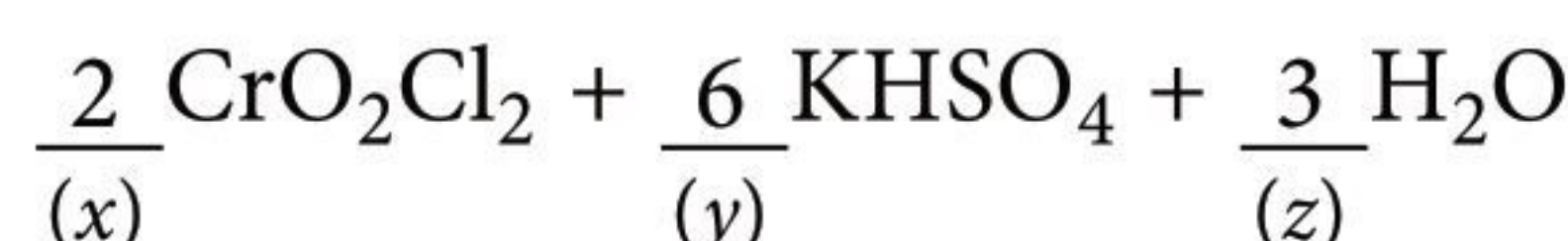
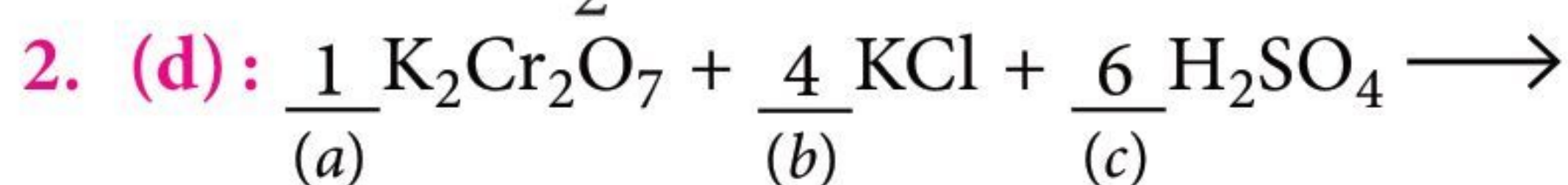
21. In how many of the following species, S-atom is sp^3 hybridised?
 S_8 , SO_4^{2-} , SO_3 , H_2S , SCl_4
22. (X) is prepared by dissolving ammonium chloride and disodium hydrogen phosphate in molecular proportion in hot water. When heated, X melts to form a clear transparent mass having the property of combining with metallic oxides to form coloured orthophosphates. The number of water molecules present in (X) is _____.
23. To 8.4 mL H_2O_2 , excess of acidified solution of KI was added. The iodine liberated required 20 mL of 0.3 N $Na_2S_2O_3$ solution. Volume strength of H_2O_2 solution is _____.
24. Consider a molecule of oxygen with a mass 5.3×10^{-26} kg trapped in a sac of diameter 5×10^{-5} m. Uncertainty in the velocity of oxygen molecule in (m/s) is _____.
25. How many of the given reactions can show slag formation process?
 (i) $SiO_2 + CaO \longrightarrow CaSiO_3$
 (ii) $FeO + SiO_2 \longrightarrow FeSiO_3$
 (iii) $CaO + P_2O_5 \longrightarrow Ca_3(PO_4)_2$
 (iv) $Cr_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Cr$
 (v) $MgCO_3 + SiO_2 \longrightarrow MgSiO_3 + CO_2$
26. On hydrolysis of one mole of calcium phosphide, how many moles of phosphine are formed?
27. In how many of the following reactions, one of the products is obtained as a yellow precipitate?
 (i) $Ba^{2+} + CrO_4^{2-} \longrightarrow$
 (ii) $Hg^{2+} + Co^{2+} + SCN^- \longrightarrow$
 (iii) $NH_4^+ + [PtCl_6]^{2-} \longrightarrow$
 (iv) $Ag^+ + CrO_4^{2-} \longrightarrow$
 (v) $NH_4^+ + [Co(NO_2)_6]^{3-} \longrightarrow$
28. The oxidation number of Mn in the product of alkaline oxidative fusion of MnO_2 is _____.
29. Consider the following list of reagents :
 Acidified $K_2Cr_2O_7$, alkaline $KMnO_4$, $CuSO_4$, H_2O_2 , Cl_2 , O_3 , HNO_3 and Na_2SO_3 . The total number of reagents that can oxidise aqueous I^- ion to I_2 is _____.
30. Find out the number of hydrogen bonds present in the structure of the nickel dimethylglyoxime complex.

SOLUTIONS

1. (b): Moles of Fe = $\frac{0.0056}{56} = 10^{-4}$ mol

2 mol of Fe = 1 mol of alum

10^{-4} mol of Fe = $\frac{1}{2} \times 10^{-4}$ mol = 0.5×10^{-4} mol



3. (b): Reaction is of second order.

$k = \frac{1}{t} \frac{x}{(a-x)} \quad t = \frac{1}{k} \frac{x}{(a-x)}$

t vs $\left(\frac{1}{\text{Conc}}\right)$ graph is linear.

4. (c): (a), (b) and (d) do not contain α -hydrogen atom and hence do not show tautomerism while (c) has α -hydrogen atom and hence it shows tautomerism.

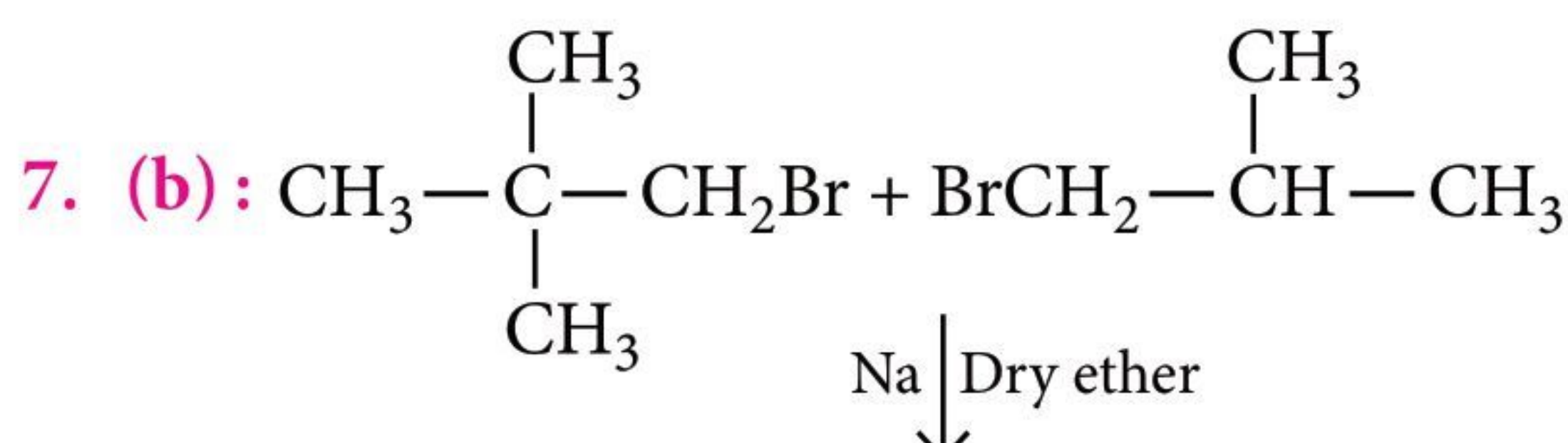
5. (a): For an isothermal process, $PV = \text{constant}$

For an adiabatic process, $PV^\gamma = \text{constant}$

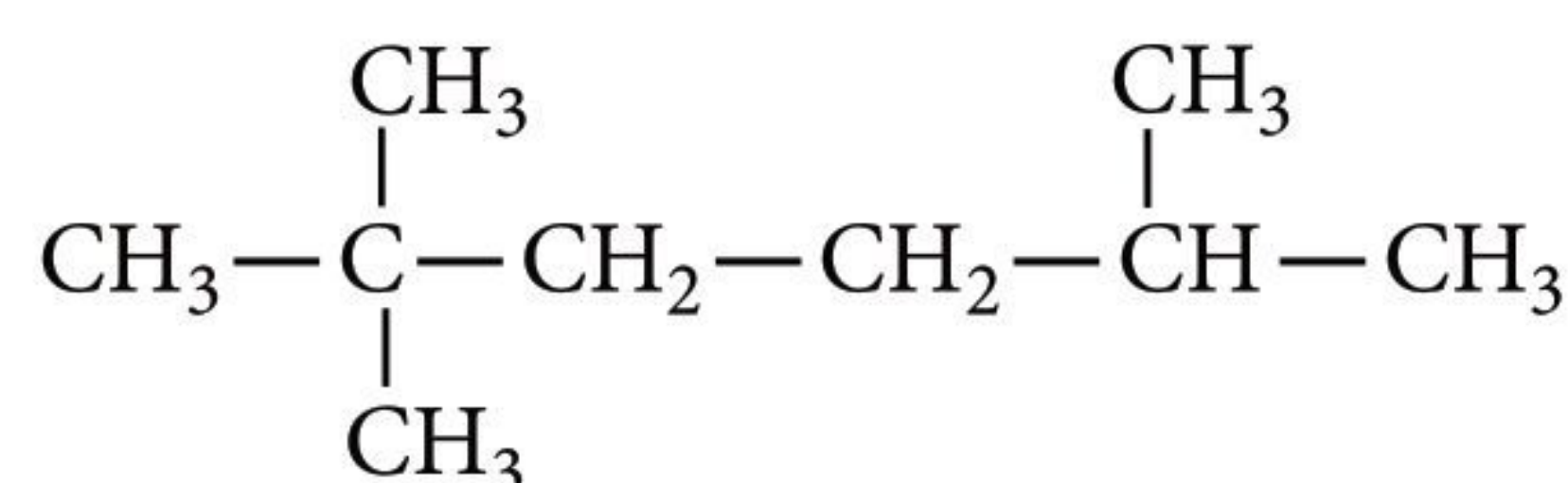
As $\gamma > 1$, P will vary more in an adiabatic process than in an isothermal process on making the same change in volume. Thus, making the curve steeper in case of an adiabatic process.

6. (c): $r = k [I^-] [S_2O_8^{2-}]$

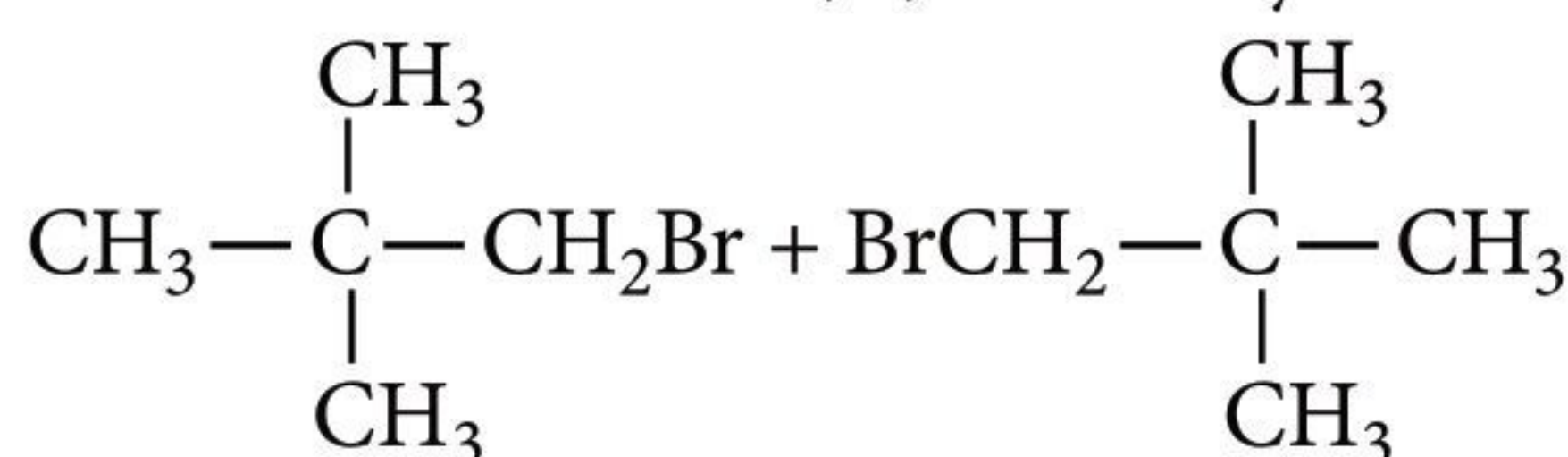
Time = $78 \times 4 = 312$ sec



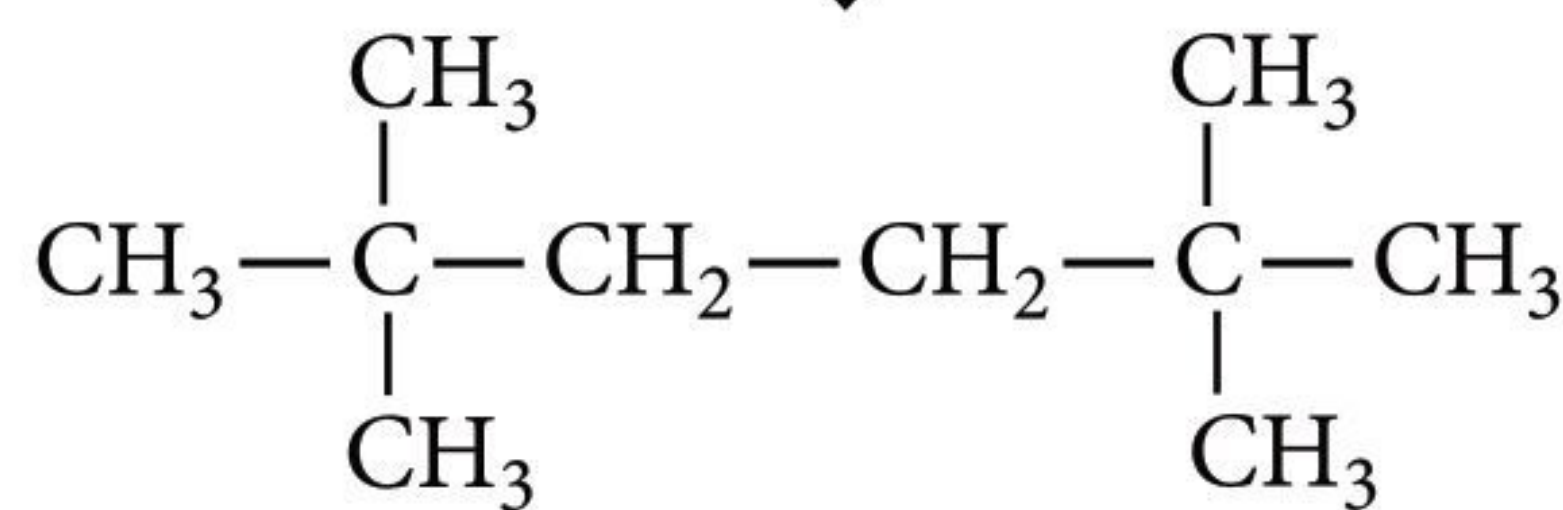
Na ↓ Dry ether



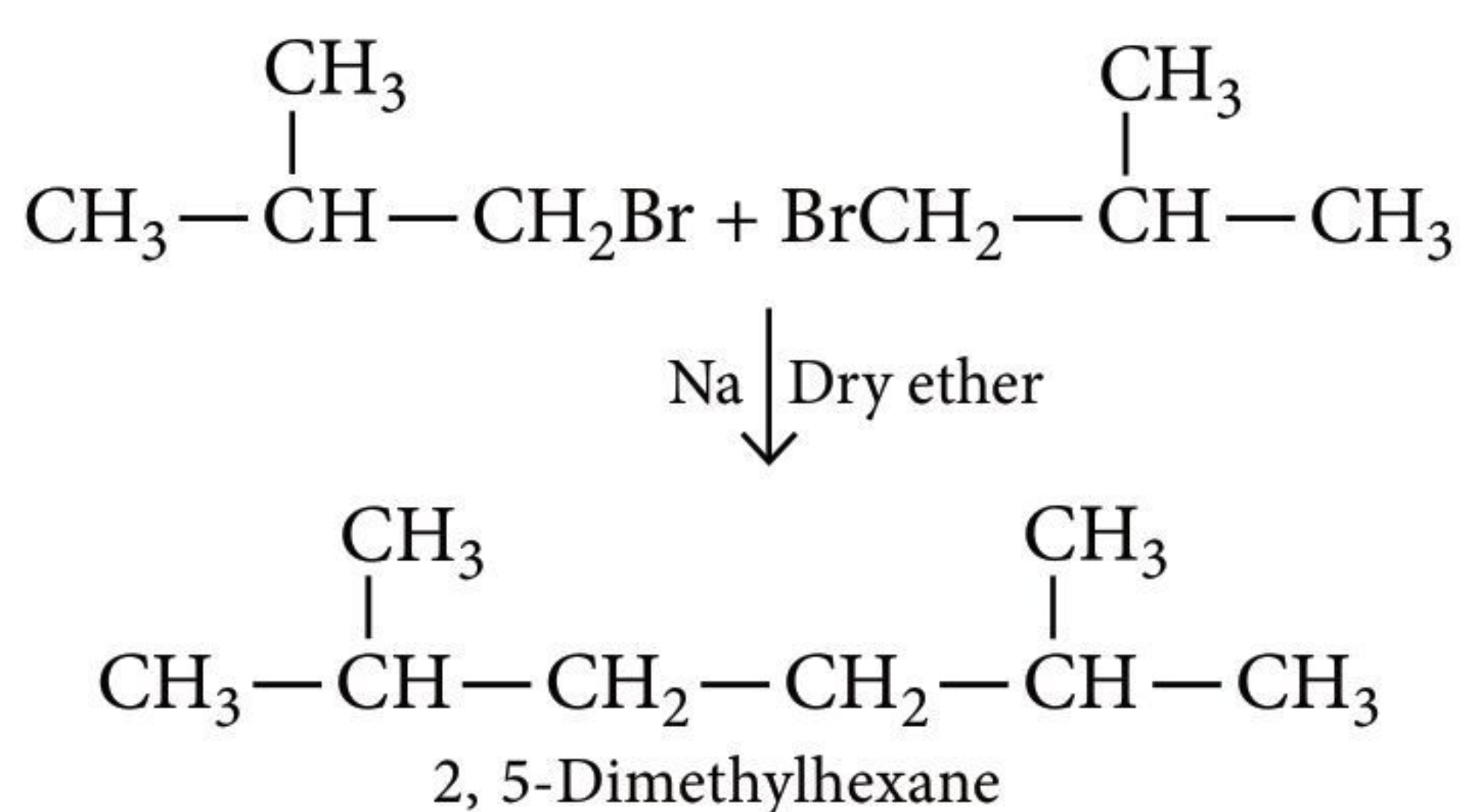
2, 2, 5 - Trimethylhexane



Na ↓ Dry ether



2, 2, 5, 5 - Tetramethylhexane



8. (d)



At half equivalence point $\text{pH} = \text{p}K_a$

10. (a)

11. (a) : $\overline{\text{KE}}_{\text{CO}} = \overline{\text{KE}}_{\text{N}_2}$, because

Average $\overline{\text{KE}} = \frac{3}{2}RT$. It does not depend upon the nature of the gas.

12. (d) : BCl_3 is sp^2 hybridised hence planar, whereas NCl_3 is sp^3 hybridised with one lone pair hence is pyramidal.

13. (c) : (i) $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$, $E_1^\circ = 0.337 \text{ V}$,

$$\Delta G_1^\circ = -n_1 F E_1^\circ \text{ and } n_1 = 2$$

(ii) $\text{Cu}^{2+} + e^- \rightarrow \text{Cu}^+$, $E_2^\circ = 0.153 \text{ V}$,

$$\Delta G_2^\circ = -n_2 F E_2^\circ \text{ and } n_2 = 1$$

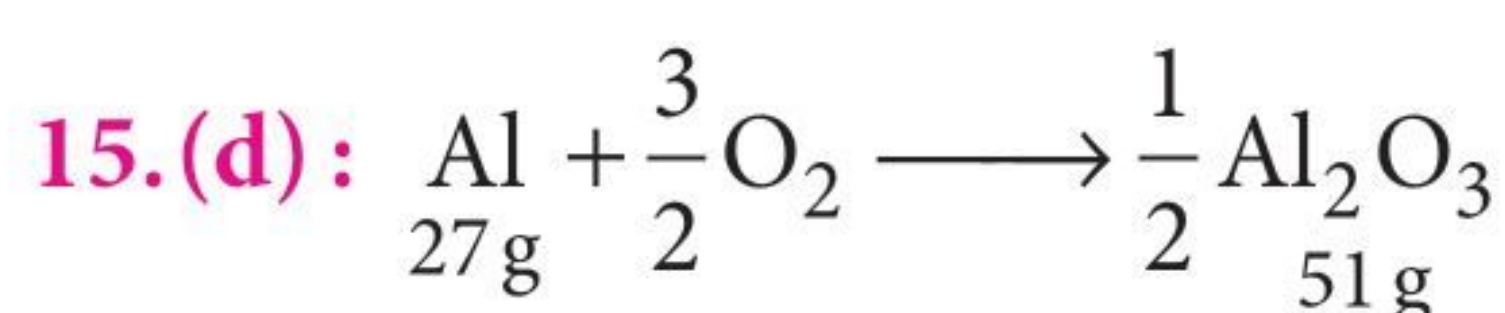
Target reaction (iii) $\text{Cu}^+ + e^- \rightarrow \text{Cu}$, $E_3^\circ = ?$, $\Delta G_3^\circ = ?$

So target equation = (i) - (ii)

$$\Delta G_3^\circ = \Delta G_1^\circ - \Delta G_2^\circ$$

$$E_3^\circ = -1\{-2 \times 0.337 + 0.153\} \text{ V} = 0.521 \text{ V}.$$

14. (a) : Acidity decreases as the electronegativity of the halogen decreases. *i.e.*,



$$\Delta H = -837.8 \text{ kJ mol}^{-1}$$

(a) 0.624 mole of Al = 837.8×0.624 on combustion gave = 523 kJ.

Hence false.

(b) Formation of 0.624 mole of Al_2O_3 gave

$$= 837.8 \times 2 \times 0.624 = 1045 \text{ kJ}$$

Hence, false.

(c) 0.312 mol of Al on combustion gave = 261 kJ.

Hence, false.

(d) Formation of 0.150 mol of Al_2O_3 gave = 251.3 kJ.

Hence, true.

16. (a) : $\text{La}(\text{OH})_3$ is more basic than $\text{Lu}(\text{OH})_3$. This is because ionic size of La^{3+} ion is more than Lu^{3+} ion (Fajan's rule).

17. (d) : When equal volumes of BaCl_2 and NaF solutions are mixed. (volume becomes double and concentration is halved).

$$(a) [\text{Ba}^{2+}] = \frac{10^{-3}}{2}, [\text{F}^-] = \frac{2 \times 10^{-2}}{2} = 10^{-2}$$

$$Q_{sp} \text{ of } \text{BaF}_2 = [\text{Ba}^{2+}] [\text{F}^-]^2 = (0.5 \times 10^{-3}) (10^{-2})^2 = 5 \times 10^{-8}$$

Since $Q_{sp} < K_{sp}$ ($5 \times 10^{-8} < 1.7 \times 10^{-7}$) precipitation will not occur.

$$(b) [\text{Ba}^{2+}] = \frac{10^{-3}}{2}, [\text{F}^-] = \frac{1.5 \times 10^{-2}}{2}$$

$$Q_{sp} \text{ of } \text{BaF}_2 = [\text{Ba}^{2+}] [\text{F}^-]^2 = (0.5 \times 10^{-3}) (0.75 \times 10^{-2})^2 = 0.28 \times 10^{-7}$$

$Q_{sp} < K_{sp}$. Hence precipitation will not occur.

$$(c) [\text{Ba}^{2+}] = \frac{1.5 \times 10^{-3}}{2}, [\text{F}^-] = \frac{10^{-2}}{2},$$

$$Q_{sp} \text{ of } \text{BaF}_2 = [\text{Ba}^{2+}] [\text{F}^-]^2 = \left(\frac{1.5 \times 10^{-3}}{2} \right) \left(\frac{10^{-2}}{2} \right)^2 = 0.187 \times 10^{-7}$$

$$Q_{sp} < K_{sp} (0.187 \times 10^{-7} < 1.7 \times 10^{-7})$$

So solution in (c) will not precipitate out.

$$(d) [\text{Ba}^{2+}] = \frac{2 \times 10^{-2}}{2} = 10^{-2} \text{ M},$$

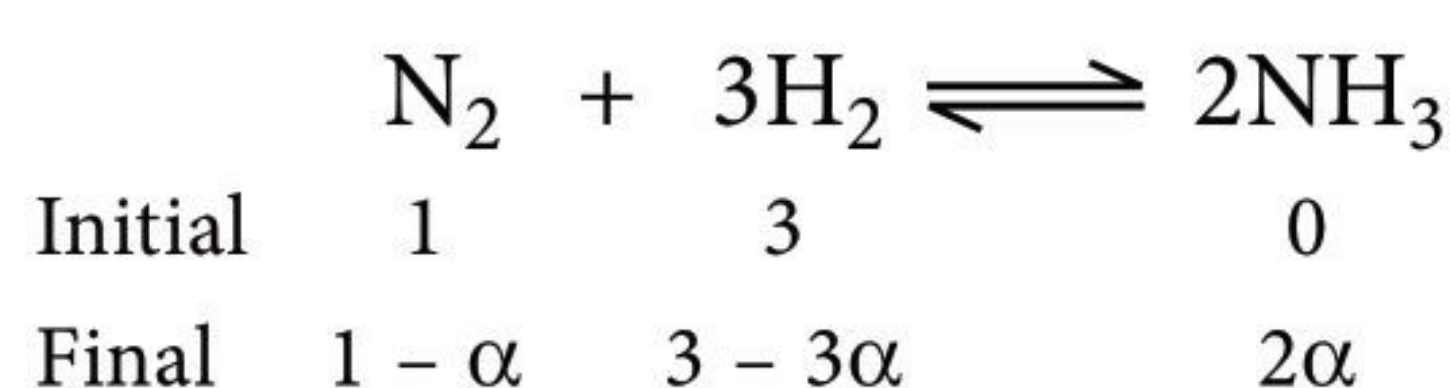
$$[\text{F}^-] = \frac{2 \times 10^{-2}}{2} = 10^{-2} \text{ M}$$

$$Q_{sp} \text{ BaF}_2 = (10^{-2}) (10^{-2})^2 = 10^{-6}$$

$\therefore Q_{sp} > K_{sp}$. Hence precipitation occurs.

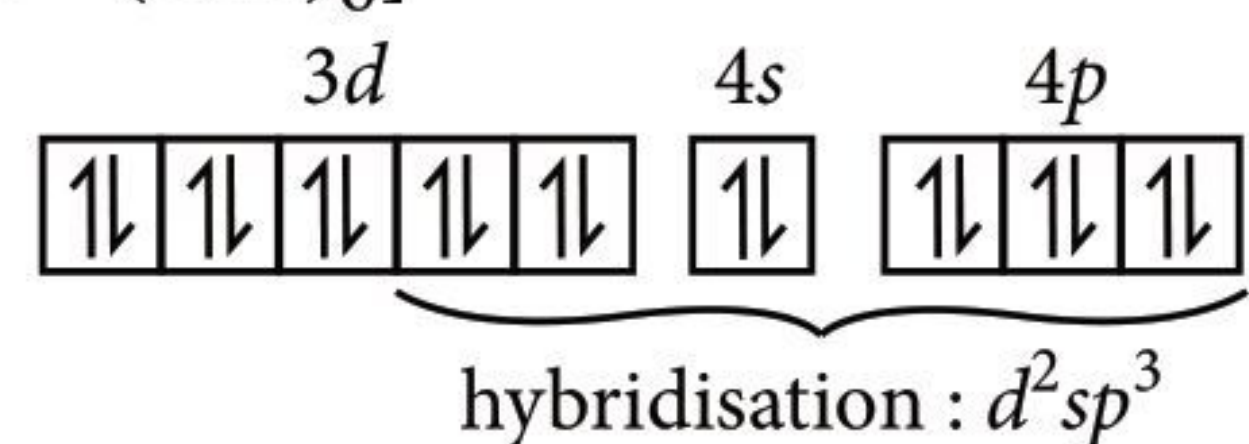
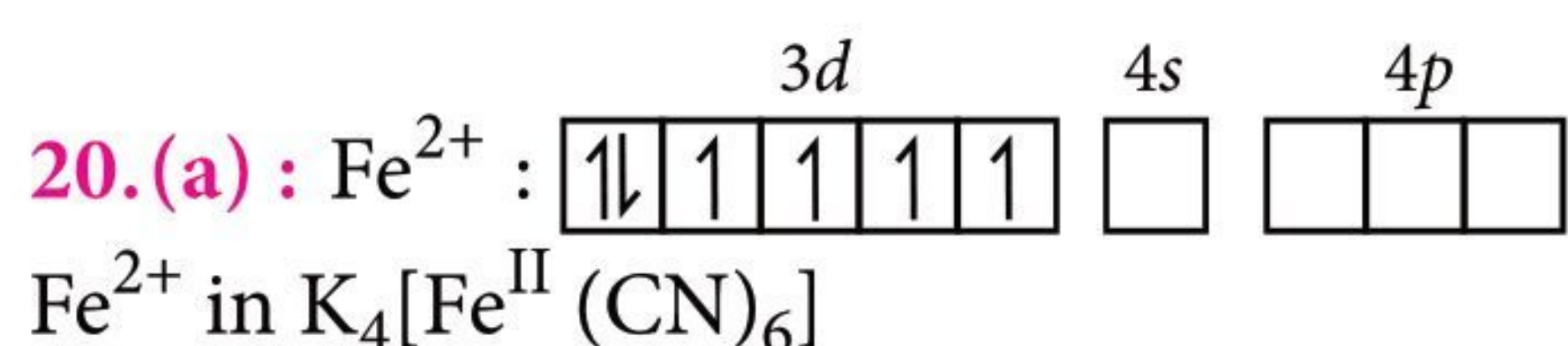
18. (b) : The acidity of phenols increases strongly due to $-I$, $-M$ group on their *ortho* and *para* positions. But *para* substituted phenol is more acidic than *ortho* substituted due to intermolecular hydrogen bonding in the *ortho* substituted phenol.

$$19. (c) : \alpha = 50\% = \frac{50}{100} = 0.5$$

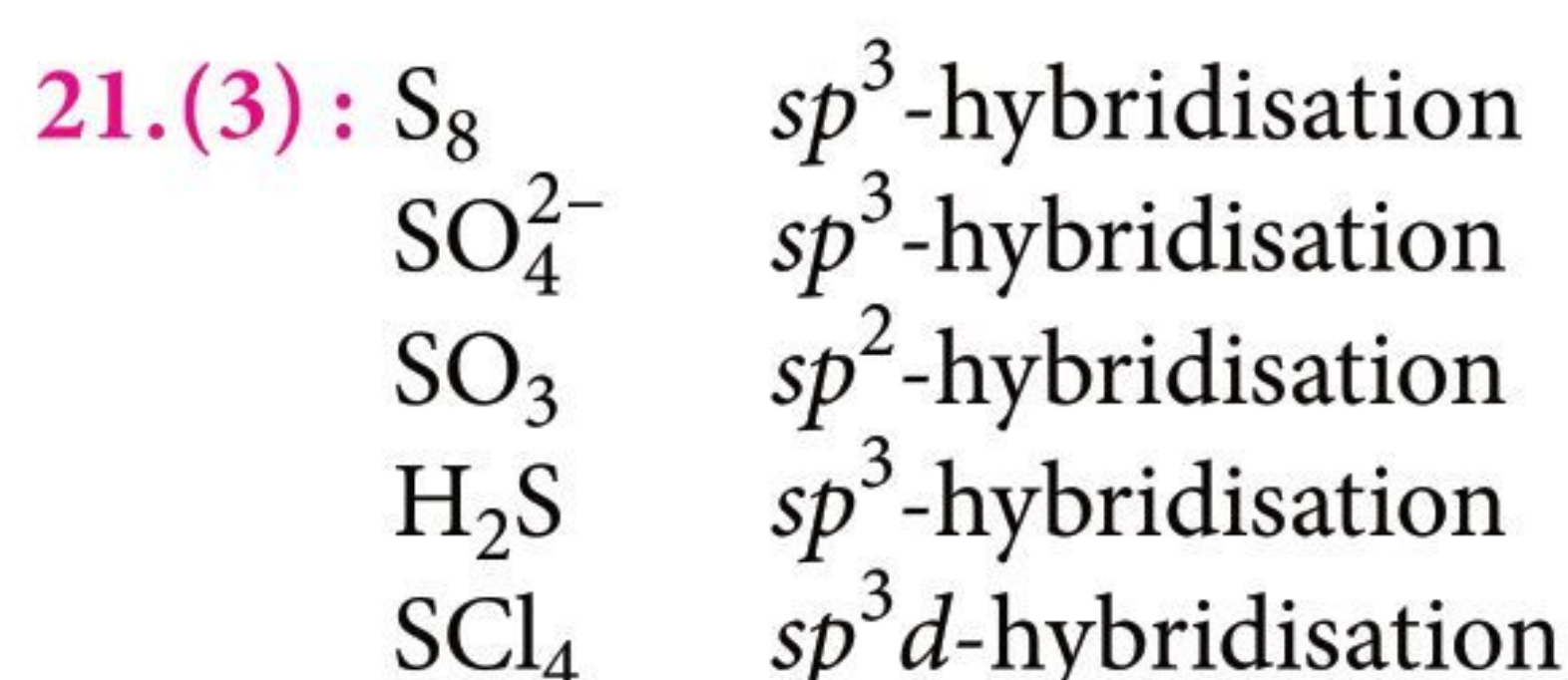


$$\text{Total moles} = 1 - \alpha + 3 - 3\alpha + 2\alpha$$

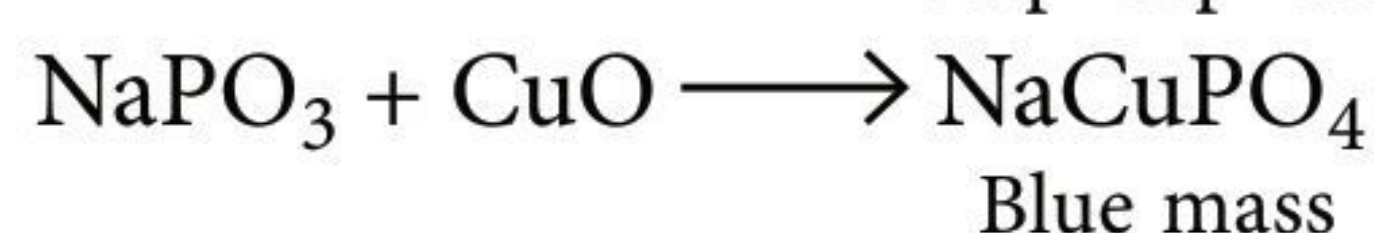
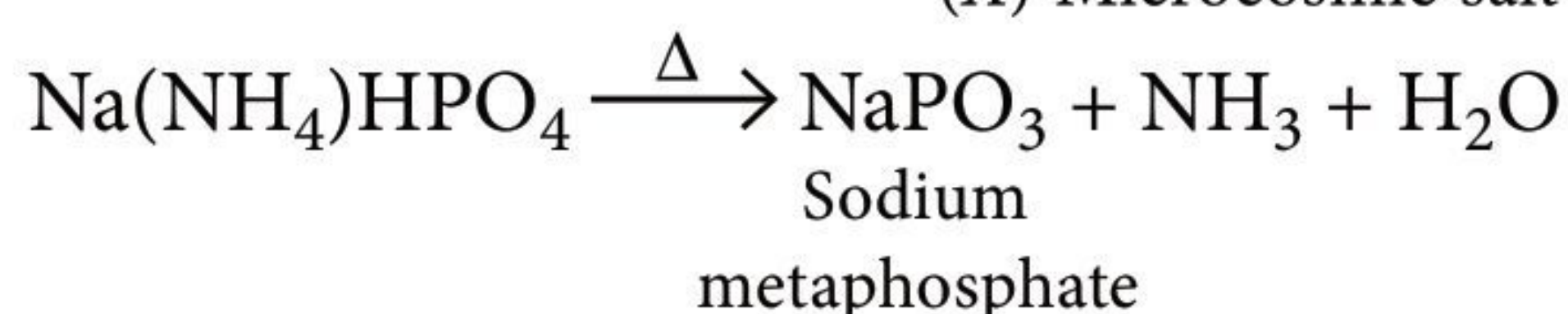
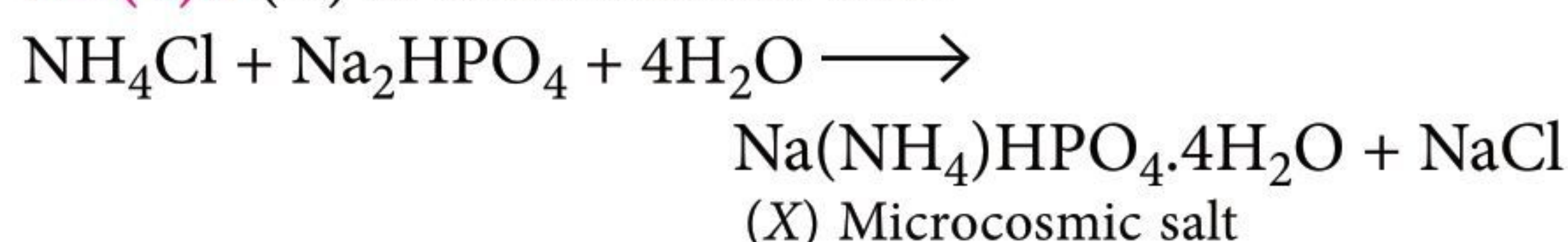
$$= 4 - 2\alpha = 4 - 2 \times 0.5 = 3$$



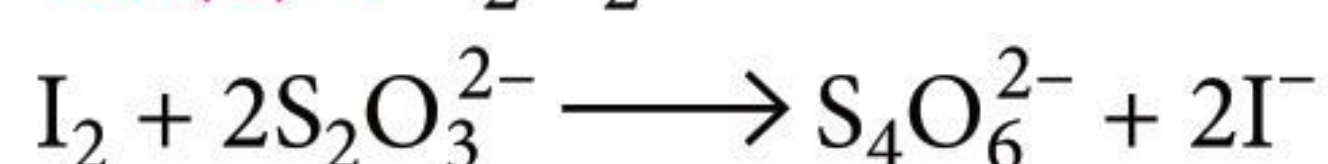
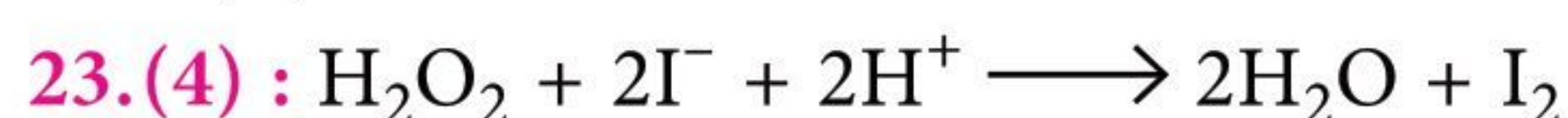
Complex is diamagnetic due to presence of paired electrons.



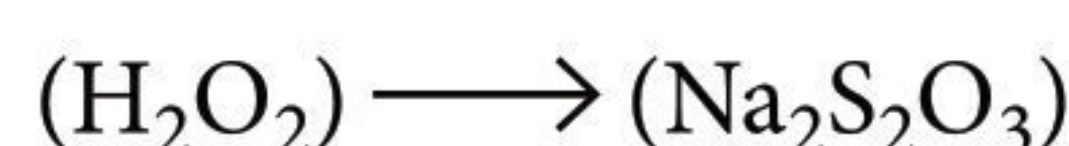
22.(4) : (X) is microcosmic salt.



Thus (X), i.e., microcosmic salt has 4 molecules of water.



$N_1 V_1 = N_2 V_2$



$N_1 \times 8.4 = 0.3 \times 20 \Rightarrow N_1 = 0.7143$

Normality of H_2O_2 is related to x (volume strength) by relation,

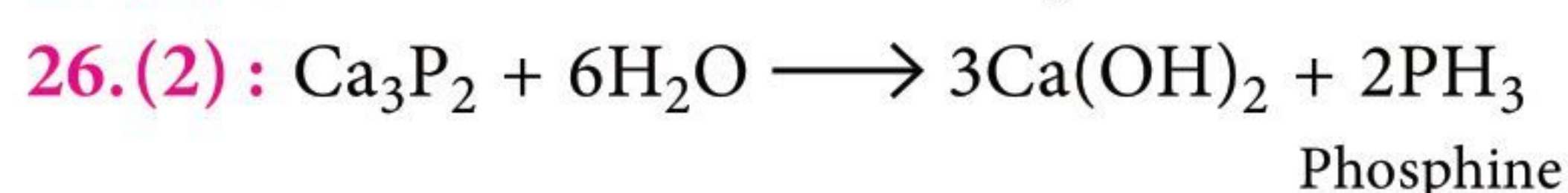
$N = \frac{x}{5.6} \Rightarrow x = N_1 \times 5.6 = 0.7143 \times 5.6 = 4$

24.(2) : Uncertainty in position $\Delta x = \text{diameter of sac}$
 $= 5 \times 10^{-10} \text{ m}$

$\Delta x \cdot \Delta v \geq \frac{h}{4\pi m}$

$\Delta v \geq \frac{6.626 \times 10^{-34}}{4 \times 3.14 \times 5.3 \times 10^{-26} \times 5 \times 10^{-10}} \approx 2 \text{ m/s}$

25.(4) : Reaction (iv) is not slag formation.

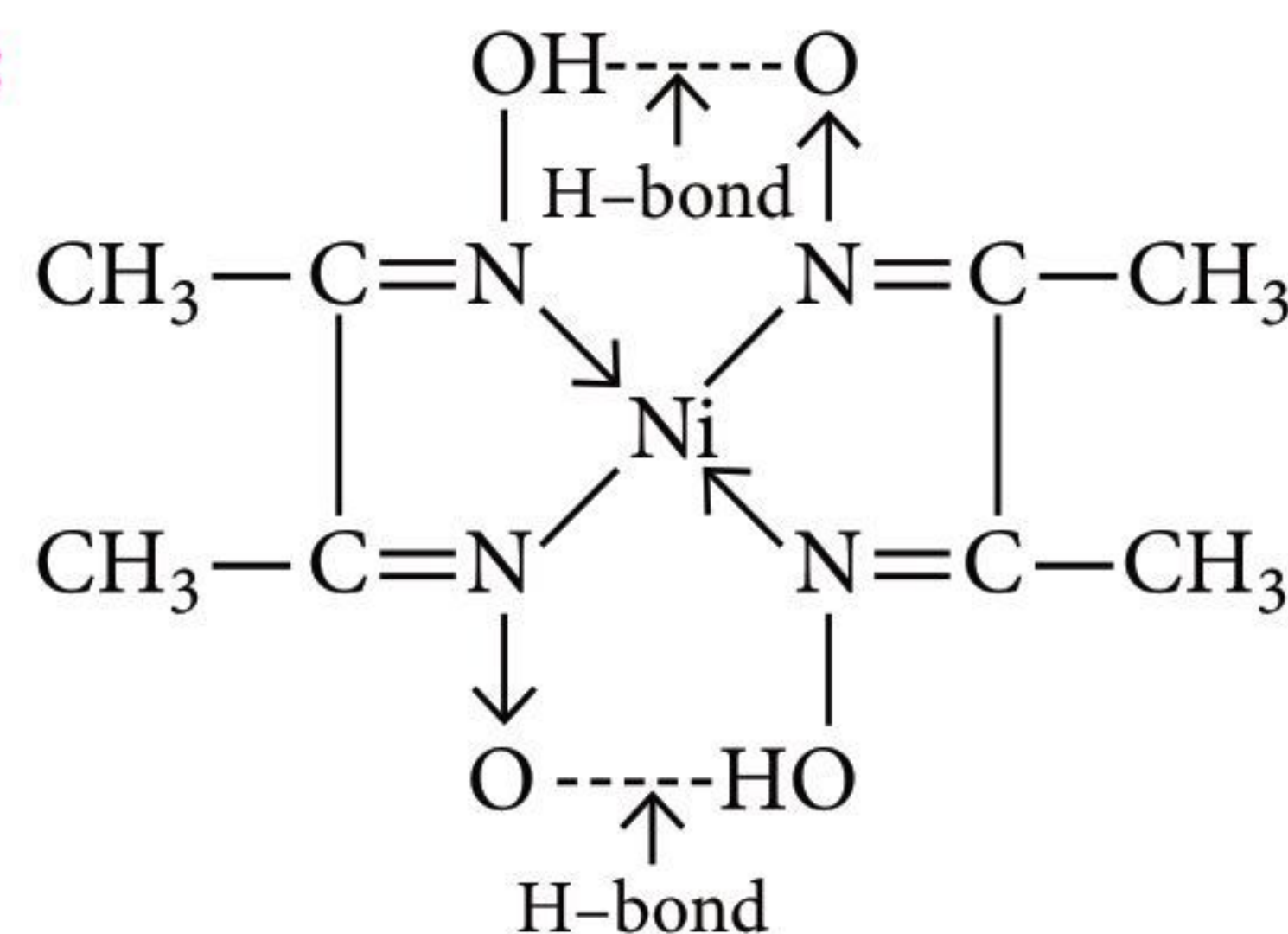


- 27.(3) : (i) Ag_2CrO_4 : (Red)
(ii) $\text{Hg}[\text{Co}(\text{SCN})_4]$: Blue
(iii) $(\text{NH}_4)_2[\text{PtCl}_6]$: Yellow
(iv) BaCrO_4 : Yellow
(v) $(\text{NH}_4)_3[\text{Co}(\text{NO}_2)_6]$: Yellow

28.(6)

29.(7) : Acidified $\text{K}_2\text{Cr}_2\text{O}_7$, alkaline KMnO_4 , CuSO_4 , H_2O_2 , Cl_2 , O_3 and HNO_3 will oxidise I^- to I_2 but $\text{Na}_2\text{S}_2\text{O}_3$ will not react with KI .

30.(2) :



For the
SCIENTIST in
YOU

Molecules that trigger post-Covid smell disorder identified!!

For many people 2-furanmethanethiol may smell like their favourite coffee, but for others it's as disgusting as burning rubbish. The compound is one of the 15 that chemists have identified as triggering parosmia, a condition that makes certain things smell burnt, rotten, or otherwise unpleasant.

The condition used to be rare but has become less since the Covid-19 pandemic because it can come with recovery from the smell loss the virus often causes. Coffee, onions, garlic, chicken and green peppers are among the most common foods that set off parosmia.

The researchers showed that a number of odour-active thiols, trisubstituted pyrazines, methoxypyrazines and disulfides are common parosmia triggers. They individually elicit the perception of revulsion, regardless of how many other aroma compounds are perceived at the same time. There are no known odour receptors which are specific for these compounds.

The 29 study participants suffering from parosmia after a virus detected more than 30 different molecules, and the most frequently reported trigger of parosmia was 2-furanmethanethiol, which has an exceptionally low odour threshold in water. For people without parosmia, the compound smells intensely of roasted coffee.

'This is solid evidence that it's not all "in the head", and that the sense of disgust can be related to the compounds in the distorted foods,' said the scientist from the University of Reading, UK, who led the research. 'The central nervous system is certainly involved as well in interpreting the signals that it receives from the nose.'

Understanding the molecules that activate parosmia can help form the basis of objective tests and improve methods to measure it beyond questionnaires or qualitative evaluations. The findings can also help scientists to explore the underlying mechanism of parosmia.

JEE 2022 PRACTICE PAPER ADVANCED

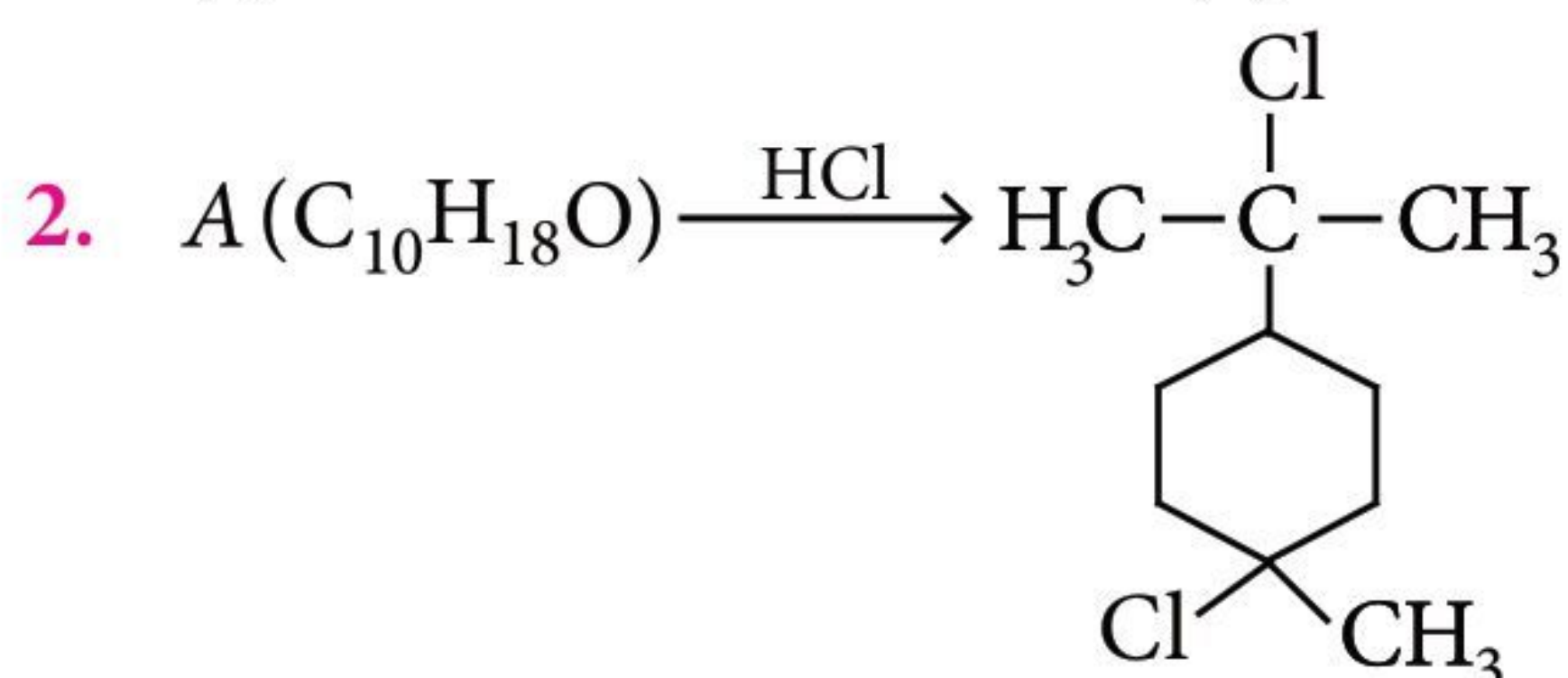
Exam on
28th August

PAPER - I

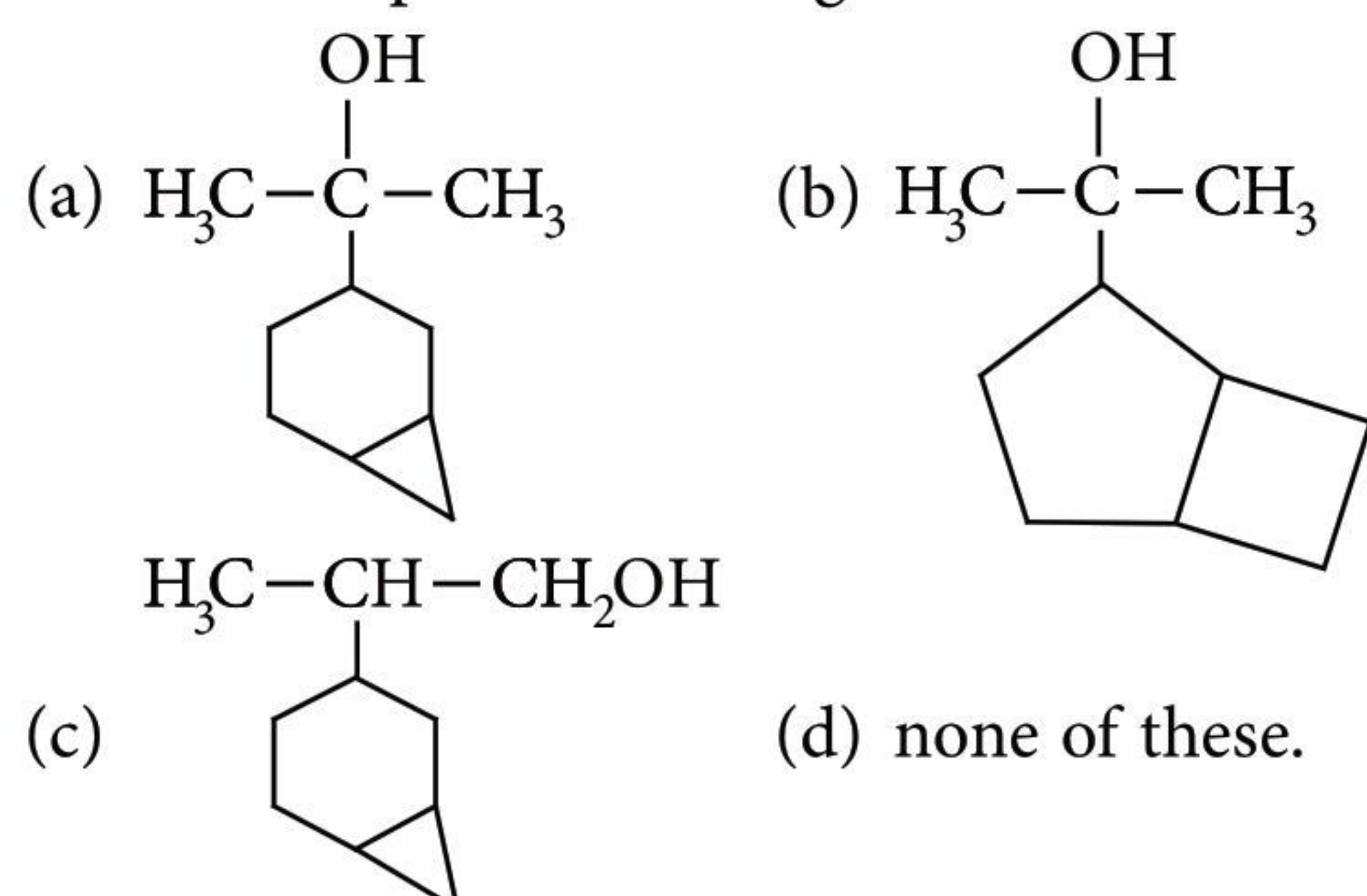
SECTION 1

- This section contains FOUR (04) questions.
- Each question has FOUR options (a), (b), (c) and (d). ONLY ONE of these four options is the correct answer.
- For each question, choose the correct option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If ONLY the correct option is chosen.
Zero Marks : 0 If none of the options is chosen (i.e., the question is unanswered).
Negative Marks : -1 In all other cases.

1. Assume that you are travelling at a speed of 90 km/h in a small car with a mass of 1050 kg. If the uncertainty in the velocity of the car is 1% ($\Delta v = 0.9$ km/h), what is the uncertainty (in meters) in the position of the car ?
- (a) $\Delta x \geq 1 \times 10^{-35}$ (b) $\Delta x \geq 2 \times 10^{-37}$
 (c) $\Delta x \geq 2 \times 10^{-36}$ (d) $\Delta x \geq 4 \times 10^{-38}$



Degree of unsaturation of A = 2, it contains no double or triple bonds. Reagent A is



3. Which of the following is ionic solid?
 (a) $\text{XeF}_{6(s)}$ (b) $\text{PBr}_{5(s)}$
 (c) $\text{CaC}_{2(s)}$ (d) All of these.
4. Liquefied natural gas (LNG) is mainly methane (MW = 16.0). A 10.0 m^3 tank is constructed to store LNG at -164°C and 1.0 atm pressure and under these conditions its density is 415 kg/m^3 . Calculate the volume of a storage tank capable of holding the same mass of LNG as a gas at 20°C and 1.0 atm pressure.
 (a) 6230 m^3 (b) 6000 m^3
 (c) 6480 m^3 (d) 7000 m^3

SECTION 2

- This section contains THREE (03) question stems.
- There are TWO (02) questions corresponding to each question stem.
- The answer to each question is a NUMERICAL VALUE.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +2 If ONLY the correct numerical value is entered at the designated place
Zero Marks : 0 In all other cases.

Question Stem for Question Nos. 5 and 6

Question Stem

For an electrode reaction written as
 $M^{n+} + ne^- \rightarrow M$

$$E_{\text{red}} = E_{\text{red}}^\circ - \frac{RT}{nF} \ln \frac{1}{[M^{n+}]} \quad (\text{Nernst equation})$$

$$= E_{\text{red}}^{\circ} - \frac{0.0591}{n} \log \frac{1}{[M^{n+}]} \text{ at } 298 \text{ K}$$

For the cell reaction, $aA + bB \rightarrow xX + yY$

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{RT}{nF} \log \frac{[X]^x [Y]^y}{[A]^a [B]^b}$$

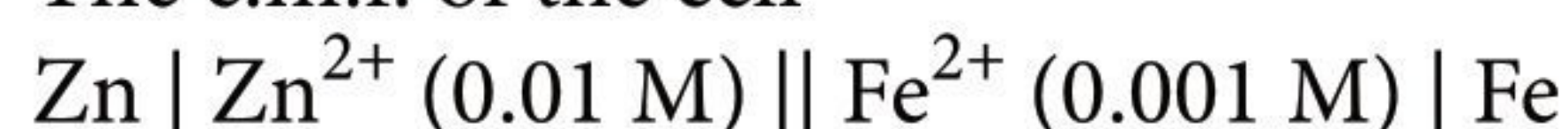
$$= E_{\text{cell}}^{\circ} - \frac{0.0591}{n} \log \frac{[X]^x [Y]^y}{[A]^a [B]^b} \text{ at } 298 \text{ K}$$

For pure solids, liquids or gases at 1 atm, molar concentration = 1

Standard free energy change, $\Delta G^{\circ} = -nFE_{\text{cell}}^{\circ}$ where n is the number of electrons transferred in the redox reaction of the cell, E_{cell}° is the standard emf of the cell. F stands for Faraday i.e., 96500 C mol^{-1} .

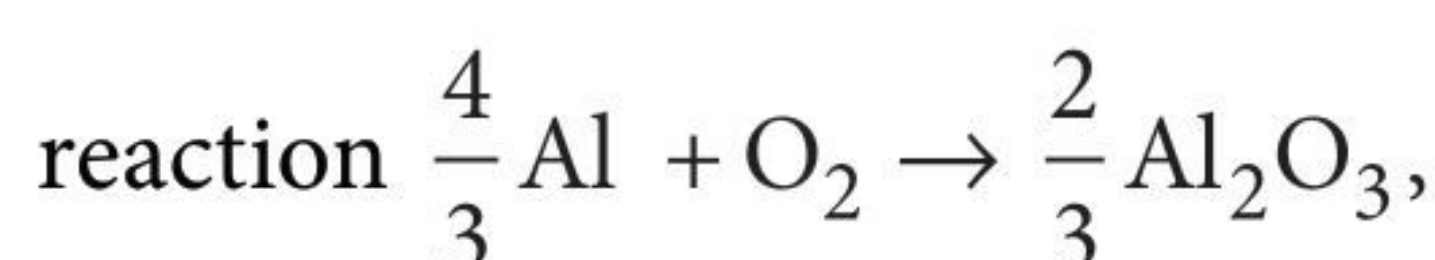
Standard free energy change, $\Delta G^{\circ} = -2.303RT \log K_c$, where K_c is the equilibrium constant at $T \text{ K}$.

5. The e.m.f. of the cell



at 298 K is 0.2905 V. The value of the equilibrium constant for cell reaction is 10^x . The value of x is _____.

6. On the basis of information available from the



$\Delta G = -827 \text{ kJ mol}^{-1}$ the minimum e.m.f. required to carry out an electrolysis of Al_2O_3 ($1F = 96500 \text{ C/mol}$) is _____.

Question Stem for Question Nos. 7 and 8

Question Stem

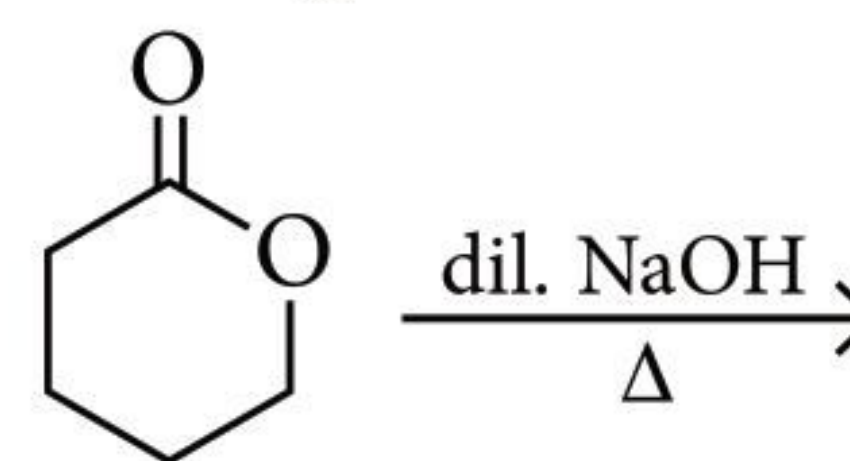
Aldol condensation is a chemical reaction in which two or more molecules of same or different carbonyl compounds containing α -hydrogen atom unite together in the presence of dilute base such as NaOH, $\text{Ba}(\text{OH})_2$ or K_2CO_3 etc. to form compounds called aldols. The term aldol is derived from the combination of words aldehyde and alcohol, the two functional groups present in the product. In such condensation, the hydrogen of one molecule at α -position with respect to the carbonyl group enters into combination with the oxygen of the carbonyl group of the other molecule forming a hydroxyl group.

Formaldehyde, though contains no α -hydrogen atom, yet undergoes aldol condensation.

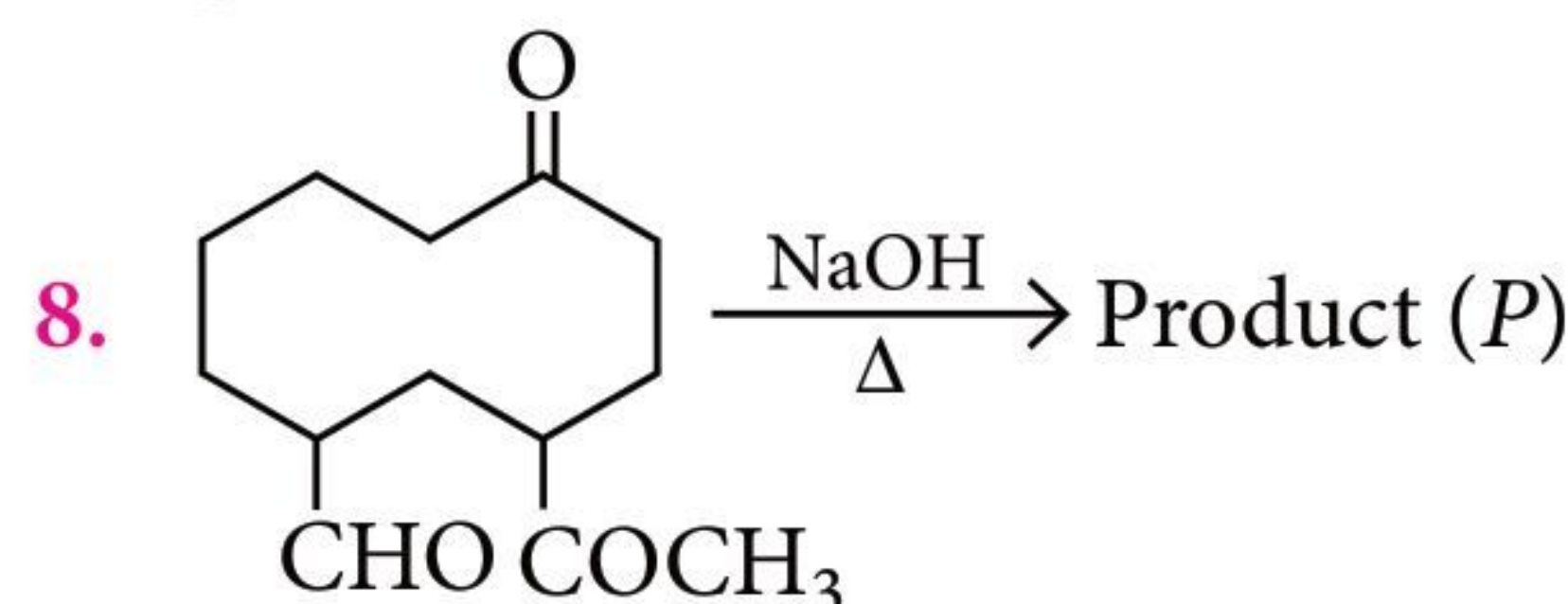
In aldol condensation

- new carbon to carbon linkage is formed.
- the condensation product i.e., aldol loses a molecule of water to form unsaturated aldehyde or ketone.

7. Consider the following reaction :



The number of C—C sigma bonds in the final product formed is _____.



The total number of carbon atoms in the larger ring is _____.

Question Stem for Question Nos. 9 and 10

Question Stem

The electrons in atoms occupy atomic orbitals (AOs) that are represented as the regions around the nuclei where there is a high probability of finding the electrons. In LCAO (linear combination of atomic orbitals) approach, when AOs come close together, they overlap forming MOs (molecular orbitals). Two AOs can overlap to form two MOs, one of which lies at a lower energy level, called bonding molecular orbital (BMO) and the other is formed at a higher energy level called antibonding molecular orbital (ABMO). Each MO can hold one or two electrons in accordance with Pauli's exclusion principle. MOT can explain the paramagnetism of molecules.

9. According to molecular orbital theory the oxygen ion in compound $\text{O}_2[\text{PtF}_6]$ possesses bond order _____.

10. The sum of bond orders of NO , O_2^- , C_2^{2-} and He_2^+ is _____.

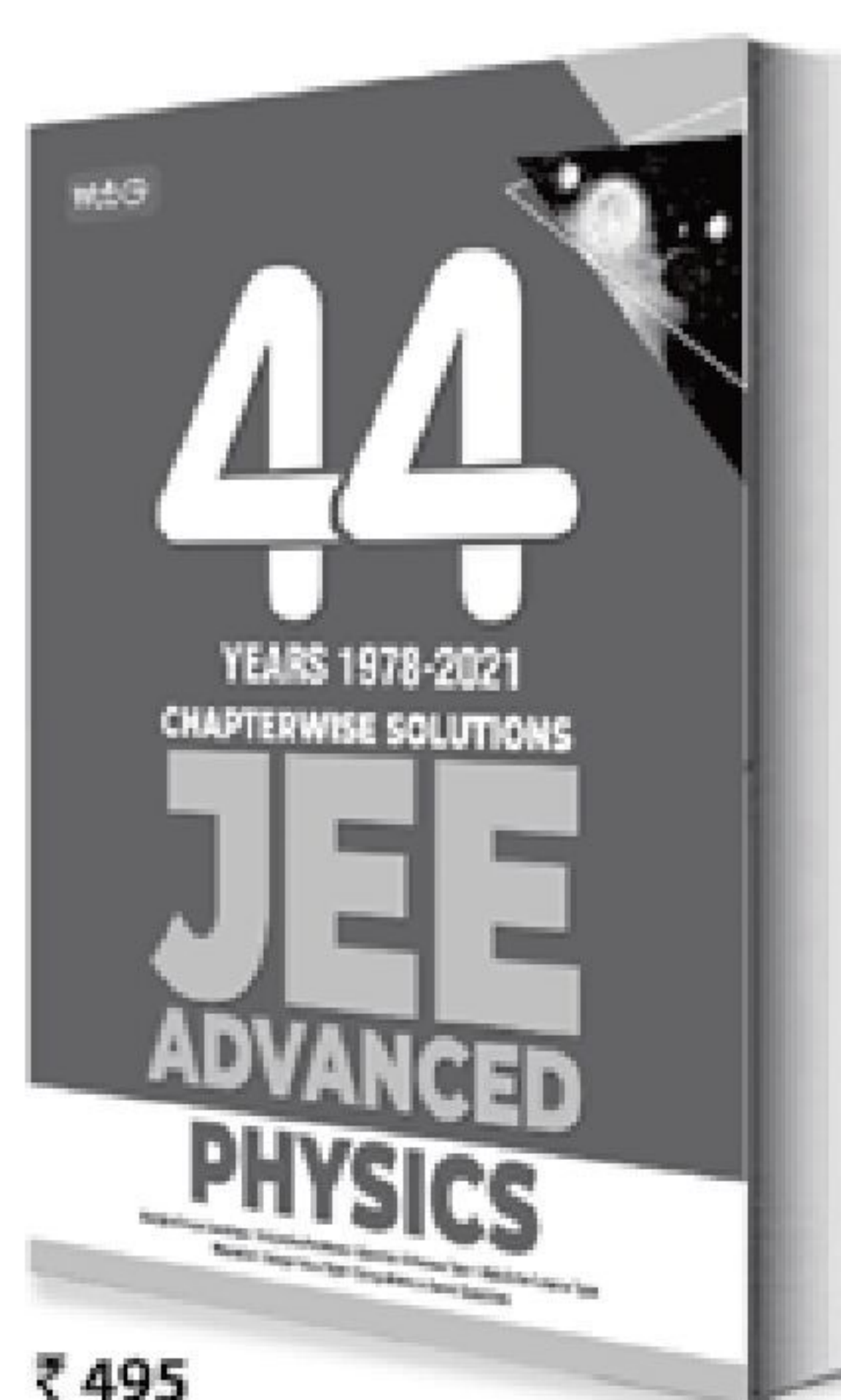
SECTION 3

- This section contains SIX (06) questions.
- Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

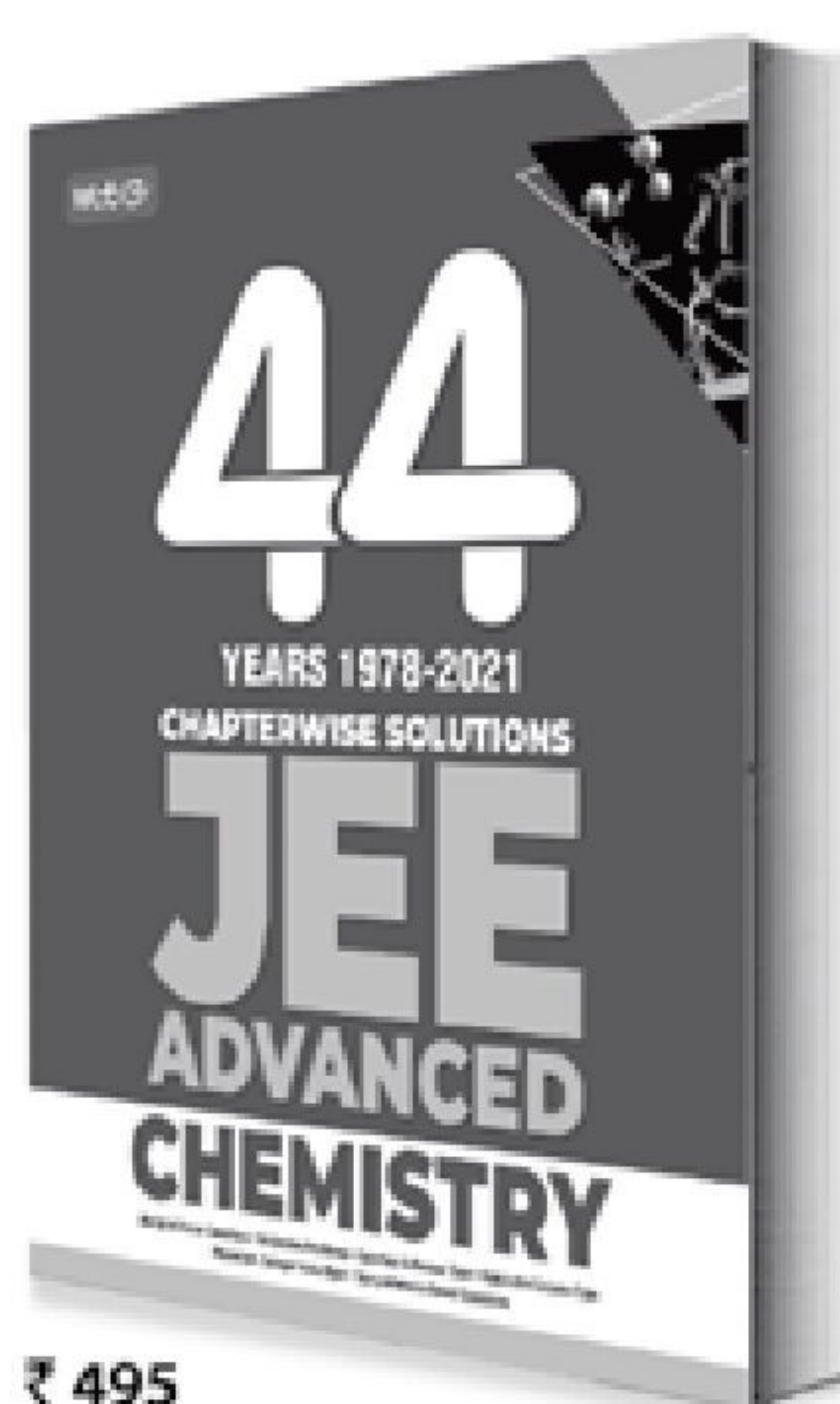
Full Marks : +4 If only (all) the correct option(s) is(are) chosen;

Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;

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Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;

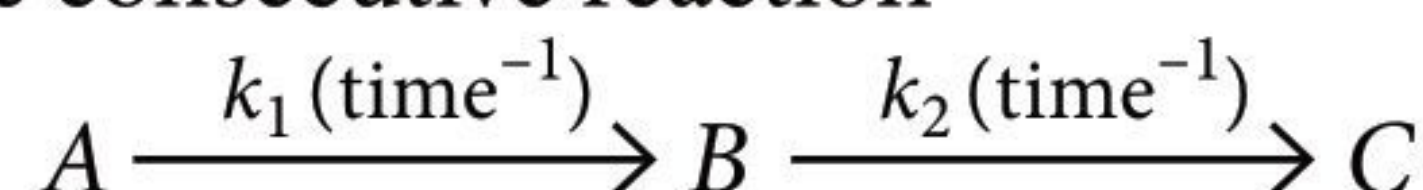
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;

Zero Marks : 0 If unanswered;

Negative Marks : -2 In all other cases.

For example, in a question, if (a), (b) and (d) are the ONLY three options corresponding to correct answers, then choosing ONLY (a), (b) and (d) will get +4 marks; choosing ONLY (a) and (b) will get +2 marks; choosing ONLY (a) and (d) will get +2 marks; choosing ONLY (b) and (d) will get +2 marks; choosing ONLY (a) will get +1 mark; choosing ONLY (b) will get +1 mark; choosing ONLY (d) will get +1 mark; choosing no option(s) (i.e., the question is unanswered) will get 0 marks and choosing any other option(s) will get -2 marks.

11. For the consecutive reaction



following curves were obtained depending upon the relative values of k_1 and k_2 .

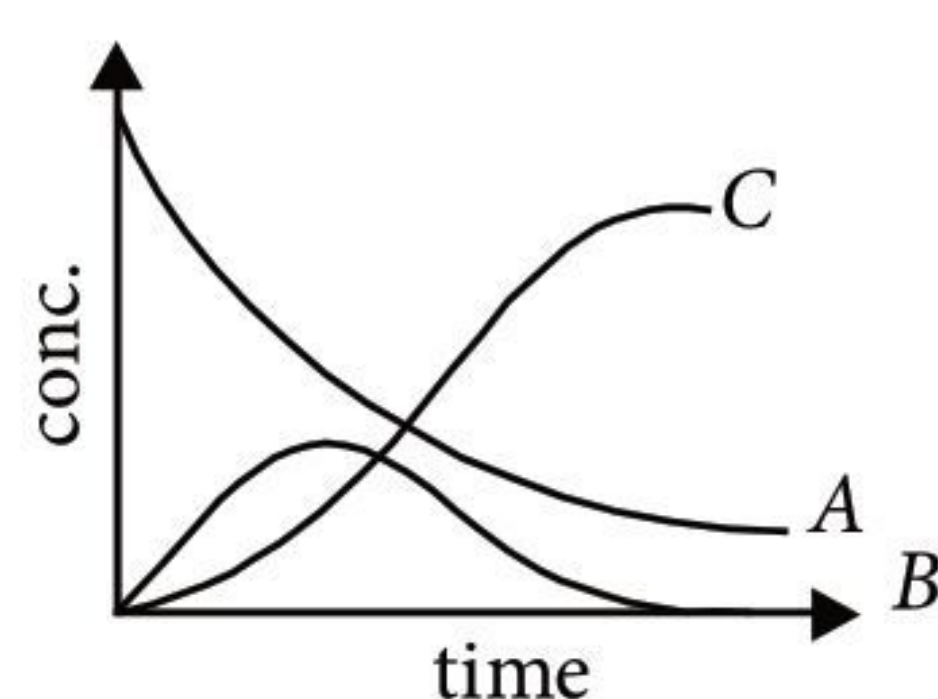


Figure 1

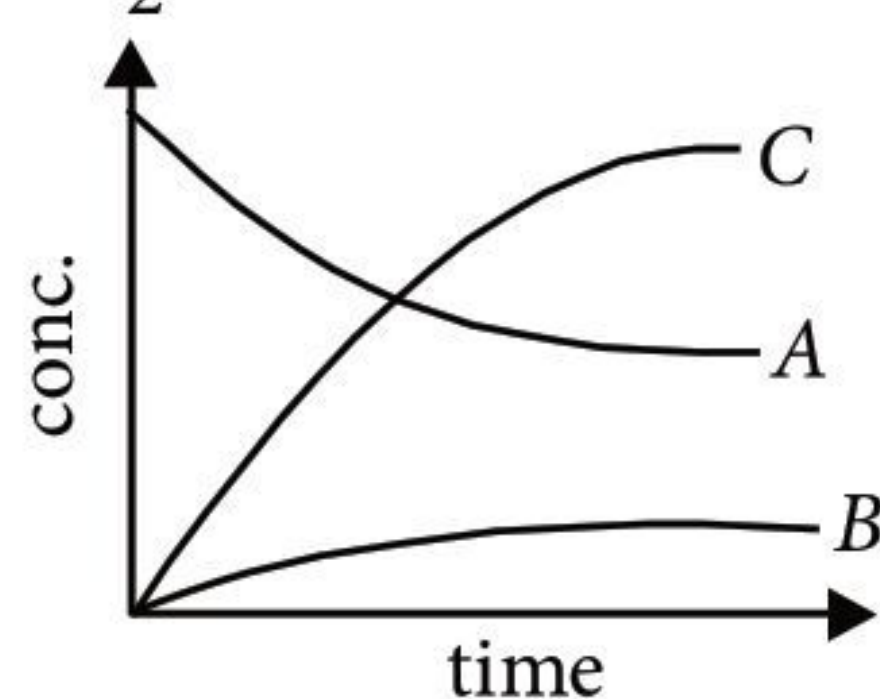
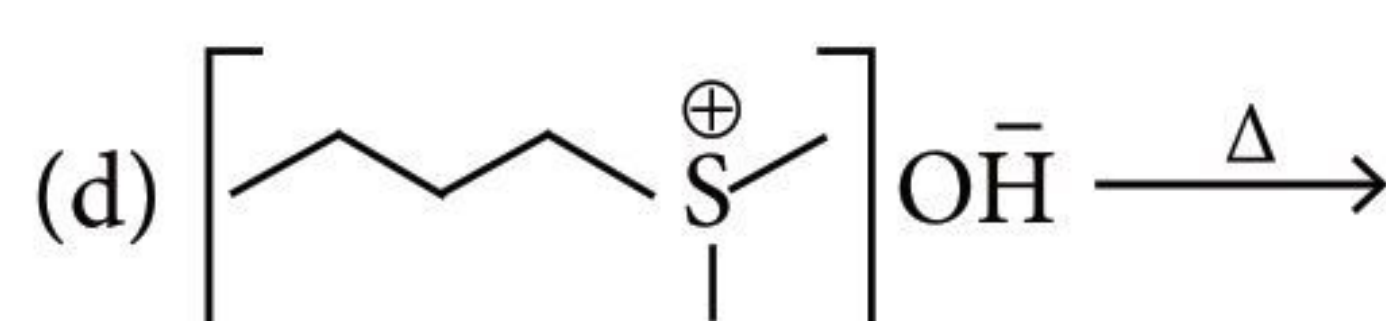
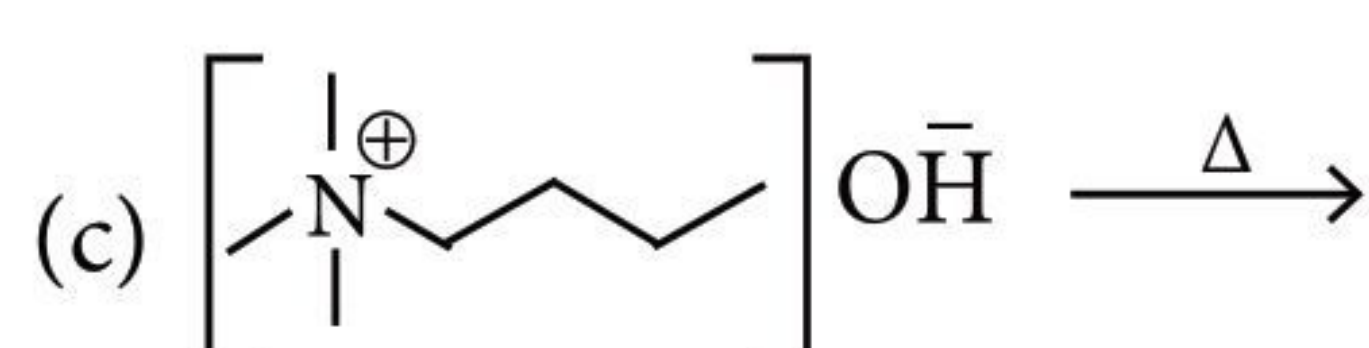
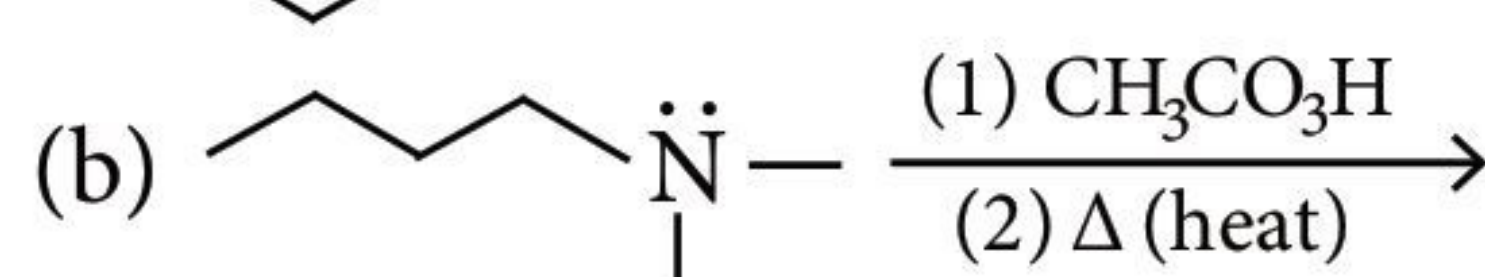
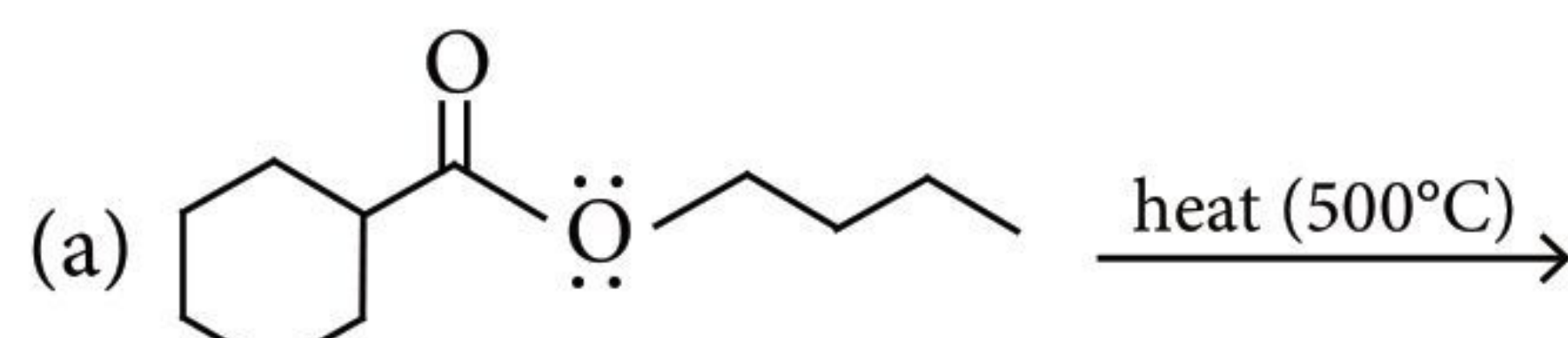


Figure 2

Now which of the following is the correct match?

- (a) Figure 1 - ($k_1 < k_2$) (b) Figure 2 - ($k_1 < k_2$)
(c) Figure 2 - ($k_1 \gg k_2$) (d) Figure 1 - ($k_1 \gg k_2$)

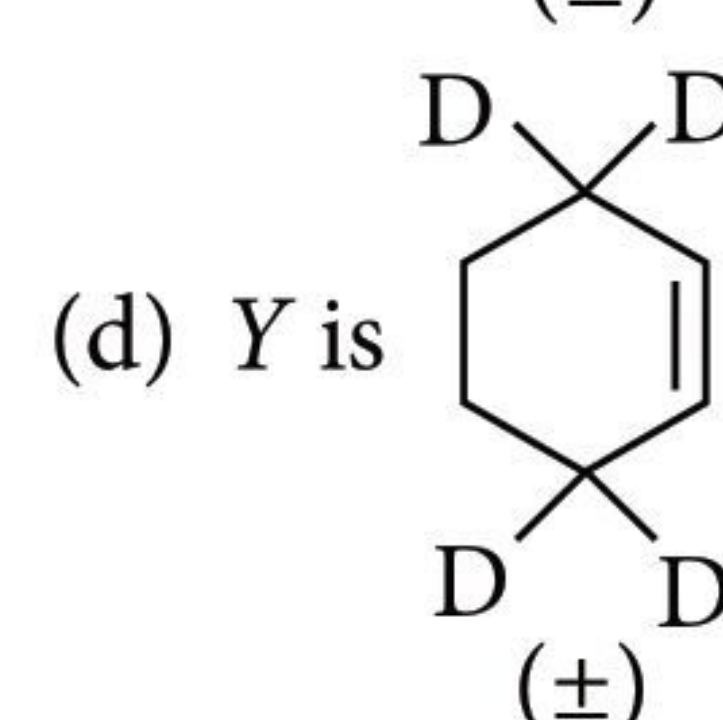
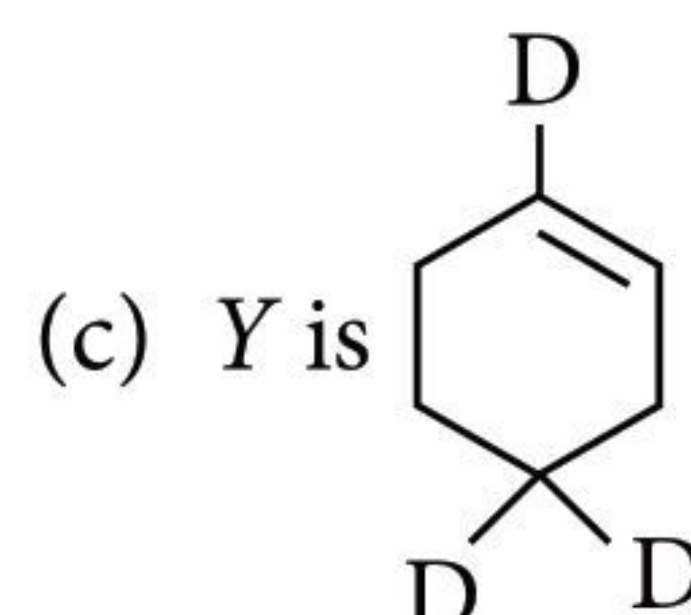
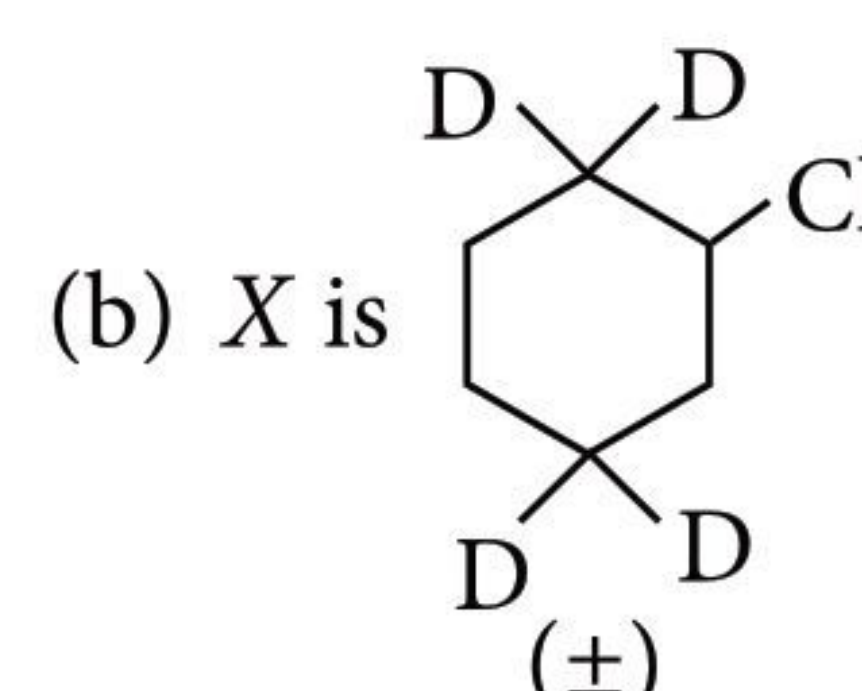
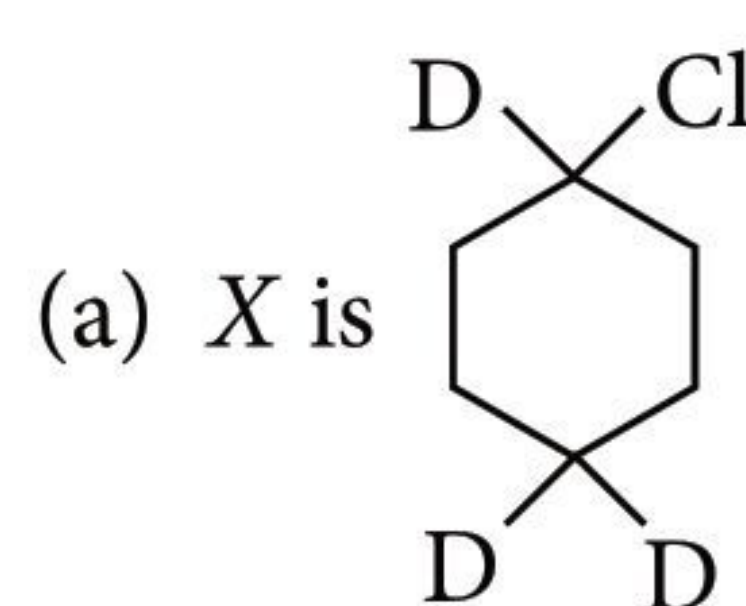
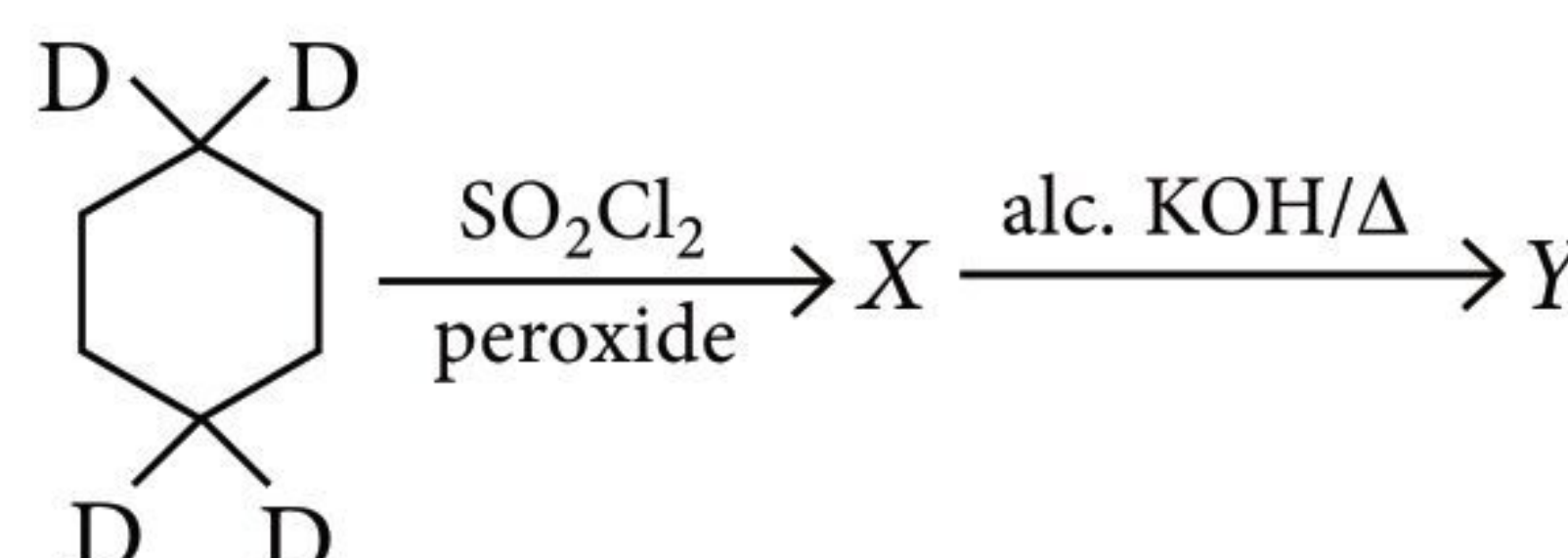
12. But-1-ene is formed in reaction/s



13. Which of the following is correct?

- (a) $\text{AgCl}_{(s)} + \text{Na}_3\text{AsO}_3 \rightarrow$ colourless solution
(b) $\text{FeCl}_{3(aq)} + \text{K}_4[\text{Fe}(\text{CN})_6]$ (excess) \rightarrow blue ppt.
(c) $\text{FeCl}_{3(aq)} + \text{K}_3[\text{Fe}(\text{CN})_6] \xrightarrow{\text{H}_2\text{O}_2}$ blue solution
(d) $\text{CuSO}_{4(aq)} + \text{KCN}$ (excess) \rightarrow Blue coloured solution

14. Which observation/s will be correct about the major products X and Y of the following reaction?



15. Let the colour of the indicator HIn (colourless) will be visible only when its ionised form (pink) is 25% or more in a solution. Suppose HIn ($\text{p}K_a = 9.0$) is added to a solution of $\text{pH} = 9.6$, predict what will happen? (Take $\log 2 = 0.3$)

- (a) Pink colour will be visible.
(b) Pink colour will not be visible.
(c) % of ionised form will be less than 25%.
(d) % of ionised form will be more than 25%.

16. Which of the following is/are wrong about P_4O_{10} molecule?

- (a) Each P atom can be considered to be sp^3 hybridised.
(b) There are four P—P bonds in the molecule.
(c) There are two types of P—O bond lengths.
(d) PPO angle is 180° .

SECTION 4

- This section contains THREE (03) questions.
- The answer to each question is a NON-NEGATIVE INTEGER.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If ONLY the correct integer is entered;

Zero Marks : 0 In all other cases.

17. A compound (P) is formed by heating xenon and fluorine in the molecular ratio of 1:20 under pressure in a nickel tube. (P) undergoes stepwise hydrolysis to yield final product (Q). (Q) is also formed when (P) is stored in glass vessels. The number of lone pairs around central atom in (Q) is_____.

18. An optically active compound (A), $C_3H_7O_2N$ forms a hydrochloride but dissolves in water to give a neutral solution. On heating with sodalime, (A) yields C_2H_7N (B). Both (A) and (B) react with $NaNO_2$ and HCl , the former yielding a compound (C) $C_3H_6O_3$, which on heating is converted to (D), $C_6H_8O_4$ while the latter yields (E), C_2H_6O . The degree of carbon to which N is attached to in (A) is_____.

19. At $10^\circ C$ the osmotic pressure of urea solution is 500 mm. The solution is diluted and the temperature is raised to $25^\circ C$, when the osmotic pressure is found to be 105.3 mm. The extent of dilution is x times. x is_____.

PAPER - II

SECTION 1

- This section contains SIX (06) questions.
- Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is(are) chosen;

Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;

Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;

Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;

Zero Marks : 0 If unanswered;

Negative Marks : -2 In all other cases.

For example, in a question, if (a), (b) and (d) are the ONLY three options corresponding to correct answers, then

choosing ONLY (a), (b) and (d) will get +4 marks;

choosing ONLY (a) and (b) will get +2 marks;

choosing ONLY (a) and (d) will get +2 marks;

choosing ONLY (b) and (d) will get +2 marks;

choosing ONLY (a) will get +1 mark;

choosing ONLY (b) will get +1 mark;

choosing ONLY (d) will get +1 mark;

choosing no option(s) (i.e. the question is unanswered) will get 0 marks and

choosing any other option(s) will get -2 marks.

1. If n and l are respectively the principal and azimuthal quantum numbers, then the expression for the calculation of the total no. of electrons in any energy level is

$$(a) \sum_{l=0}^{l=n} 2(2l+1) \quad (b) \sum_{l=n+1}^{l=n-1} 2(2l+1)$$

$$(c) \sum_{l=0}^{l=n+1} 2(2l+1) \quad (d) \sum_{l=0}^{l=n-1} 2(2l+1)$$

2. Calculate van der Waals' constants a and b if critical temperature and critical pressure are $30^\circ C$ and 72 atm respectively.

- (a) $a = 3.59 \text{ L}^2 \text{ atm mol}^{-2}$
 (b) $a = 4.78 \text{ L}^2 \text{ atm}^{-1} \text{ mol}^2$
 (c) $b = 0.43 \text{ mol L}^{-1}$
 (d) $b = 0.043 \text{ L mol}^{-1}$

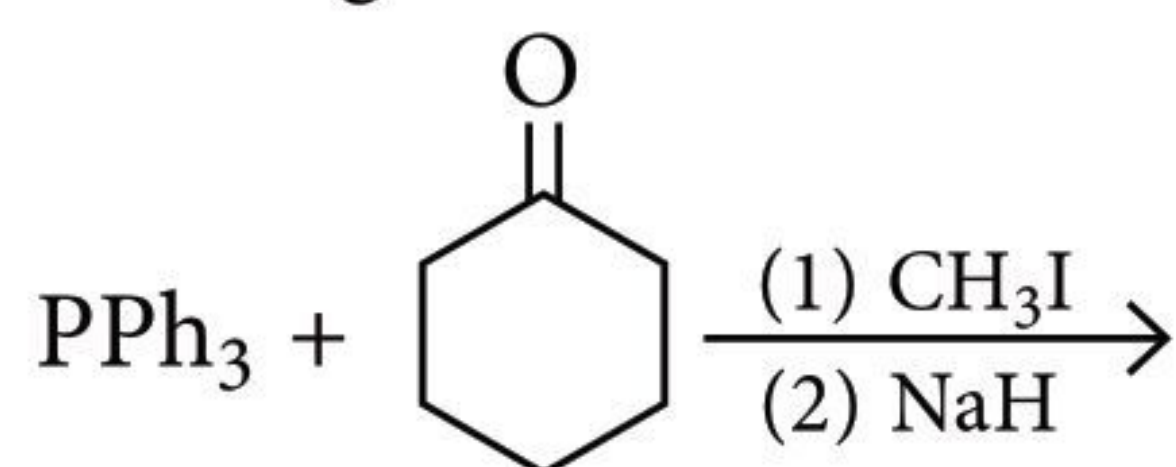
3. Consider the following S_N2 reactions

- I. $RX + Y^- \longrightarrow R - Y + X^-$
 II. $RX + Y \longrightarrow R - Y^+ + X^-$
 III. $RX^+ + Y^- \longrightarrow R - Y + X$
 IV. $RX^+ + Y \longrightarrow R - Y^+ + X$

In which reactions there is large increase and large decrease in rate of reaction respectively with increase in polarity of the solvent?

- (a) II and III (b) II and IV
 (c) I and IV (d) IV and I

4. How many membered ring(s) is/are formed in the product of following reaction?



- (a) 4 (b) 3 (c) 5 (d) 6
5. Which of the following reaction(s) is (are) feasible as per given chemical equations?
- (a) $\text{CF}_3\text{I} + \text{OH}^-_{(\text{aq})} \longrightarrow \text{CF}_3\text{H} + \text{IO}^-_{(\text{aq})}$
- (b) $\text{Rb}[\text{ICl}_2] \xrightarrow{\Delta} \text{RbCl} + \text{ICl}$
- (c) $\text{R}_2\text{SiCl}_2 \xrightarrow{\text{hydrolysis}} \text{R}_2\text{Si}(\text{OH})_2 \longrightarrow \text{R}_2\text{Si}=\text{O}$
- (d) $2\text{KBr} + \text{I}_2 \longrightarrow 2\text{KI} + \text{Br}_2$
6. In which of the following reactions is $K_p < K_c$?
- (a) $\text{CO}_{(\text{g})} + \text{Cl}_{2(\text{g})} \rightleftharpoons \text{COCl}_{2(\text{g})}$
- (b) $\text{CO}_{(\text{g})} + 3\text{H}_{2(\text{g})} \rightleftharpoons \text{CH}_{4(\text{g})} + \text{H}_2\text{O}_{(\text{g})}$
- (c) $2\text{BrCl}_{(\text{g})} \rightleftharpoons \text{Cl}_{2(\text{g})} + \text{Br}_{2(\text{g})}$
- (d) $\text{I}_{2(\text{g})} \rightleftharpoons 2\text{I}_{(\text{g})}$

SECTION 2

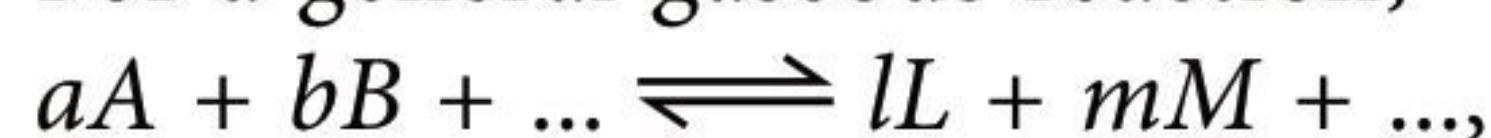
- This section contains **THREE (03)** question stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- If the numerical value has more than two decimal places, truncate/round-off the value to **TWO decimal places**.
- Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +2 **If ONLY the correct numerical value is entered at the designated place;**
Zero Marks : 0 **In all other cases.**

Question Stem for Question Nos. 7 and 8

Question Stem

Chemical equilibrium may be defined as the state of a reversible reaction when the two opposing reactions occur at the same rate and the concentrations of reactants and products do not change with time.

For a general gaseous reaction,



$$K_p = \frac{p_L^l \times p_M^m \times \dots}{p_A^a \times p_B^b \times \dots}; K_c = \frac{[\text{L}]^l [\text{M}]^m \dots}{[\text{A}]^a [\text{B}]^b \dots}$$

Equilibrium constants K_p and K_c are related as

$$K_p = K_c (RT)^{\Delta n_g}$$

where $\Delta n_g = (l + m + \dots) - (a + b + \dots)$, the difference of the sum of the coefficients for the gaseous products and reactants.

According to Le-Chatelier's principle, if a system in equilibrium is subjected to a change of concentration, pressure or temperature, the equilibrium shifts in the direction that tends to undo the effects of the change imposed.

7. In the Haber process, metallic oxide catalyses, reaction between gaseous nitrogen and hydrogen to yield ammonia whose volume at STP relative to the total volume of reactants is x times. The value of x is _____.
8. An amount of solid NH_4HS is placed in a flask already containing ammonia gas at a certain temperature and 0.50 atm pressure. Ammonium hydrogen sulphide decomposes to yield NH_3 and H_2S gases in the flask. When the decomposition reaction reaches equilibrium, the total pressure in the flask rises to 0.84 atm. The equilibrium constant (atm^2) for NH_4HS decomposition at this temperature is _____.

Question Stem for Question Nos. 9 and 10

Question Stem

The group VA elements directly combine with halogens to form trihalides, MX_3 . All the trihalides of these elements are stable except for NCl_3 , NBr_3 and NI_3 . The unstable nature of NCl_3 , NBr_3 and NI_3 is due to the weakness of $\text{N}-\text{Cl}$, $\text{N}-\text{Br}$ and $\text{N}-\text{I}$ bonds because of the large size difference between N and the halogens. The trihalides have a tetrahedral structure involving sp^3 -hybridisation with a lone pair of electrons in the fourth orbital because of which they act as Lewis bases. BiF_3 and to some extent SbF_3 are ionic.

The trihalides of phosphorus and antimony especially fluorides and chlorides act as Lewis acids also by using vacant d -orbitals. Except NF_3 and PF_3 , the trihalides of these elements are readily hydrolysed by water.

NF_3 is not hydrolysed due to lack of vacant d -orbitals in N and F. PF_3 is not hydrolysed due to stronger $\text{P}-\text{F}$ bonds as compared to $\text{P}-\text{O}$ bond.

Pentahalides are formed by P, As and Sb.

9. Some pentafluorides of group 15 elements are given below. How many of these, can exist and are stable?

- (i) PF_5 (ii) AsF_5
(iii) SbF_5 (iv) BiF_5

10. In PCl_5 , phosphorus undergoes $s^x p^y d^z$ -hybridisation the value of $y + z$ is _____.

Question Stem for Question Nos. 11 and 12

Question Stem

Organic compounds in which a metal atom is directly linked to carbon or organic compounds which contain at least one carbon-metal bond are called organometallic compounds. The ionic character of carbon-metal bond increases with electropositive character of metal. The reactivity of metal alkyls increases with increase in ionic character. The carbon atom constitutes the negative end of the metal-carbon polar covalent bond. Mostly organometallic compounds are prepared by reaction of alkyl halides with metals. 1, 4 or higher dihalides can form independent salts like Grignard reagent with Mg. Organometallic compounds are mostly colourless, mobile liquids having low boiling points and are generally very unstable. The organometallic compounds give double decomposition reactions with compounds having acidic hydrogen, nucleophilic addition reactions with carbonyl or cyanide functional groups and nucleophilic substitution reactions with alkyl halides (or tosylates). The reactivity order of these compounds for different functional groups is

Acidic 'H' > $\text{R}-\text{CHO}$ > R_2CO > RCOOR' > $\text{R}-\text{X}$

11. $\text{Br}-\text{C}_4\text{H}_8-\text{Cl} \xrightarrow{\text{Mg/ether}} \text{A} \xrightarrow{\text{D}_2\text{O}} \text{B} \xrightarrow{\text{Na/ether}} \text{C}$

The sum of four membered rings, five membered rings and number of deuterium atoms in C _____.

12. $\text{CH}_3\text{CH}_2\text{C}(=\text{O})\text{CH}_3 + \text{CH}_3\text{MgBr} \xrightarrow{\text{Ether}} \text{A} \xrightarrow{\text{H}_3\text{O}^+} \text{B}$

The number of carbon atoms in 'B' is _____.

SECTION 3

- This section contains TWO (02) paragraphs. Based on each paragraph, there are TWO (02) questions.
- Each question has FOUR options (a), (b), (c) and (d). ONLY ONE of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.

- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen;

Zero Marks : 0 If none of the options is chosen (i.e., the question is unanswered);

Negative Marks : -1 In all other cases.

Paragraph-1

Following data are given for the reaction between A and B where reactions is 2nd order w.r.t A and 1st order w.r.t. B.

[A]/mol L ⁻¹	[B]/mol L ⁻¹	Initial rate/mol L ⁻¹ s ⁻¹ at	
		300 K	320 K
2.5×10^{-4}	3.0×10^{-5}	5.0×10^{-4}	2.0×10^{-3}
5.0×10^{-4}	6.0×10^{-5}	4.0×10^{-3}	—
1.0×10^{-3}	6.0×10^{-5}	1.6×10^{-2}	—

13. The energy of activation is

- (a) 66.72 kJ mol⁻¹ (b) 55.33 kJ mol⁻¹
(c) 78.89 kJ mol⁻¹ (d) 48.23 kJ mol⁻¹.

14. The pre exponential factor is

- (a) $1.145 \times 10^{18} \text{ M}^{-2} \text{ s}^{-1}$
(b) $2.325 \times 10^{18} \text{ M}^{-2} \text{ s}^{-1}$
(c) $3.845 \times 10^{18} \text{ M}^{-2} \text{ s}^{-1}$
(d) $4.053 \times 10^{18} \text{ M}^{-2} \text{ s}^{-1}$.

Paragraph-2

Xenon, because of its lowest ionisation energy in its group, can form compounds with oxygen and fluorine. The compounds XeF_2 , XeF_4 and XeF_6 are all white solids. They can be sublimed at room temperature, and can be stored indefinitely in nickel containers. The lower fluorides form higher fluorides when heated with F_2 under pressure. The fluorides are all extremely strong oxidising and fluorinating agents.

The fluorides differ in their reactivity with water. XeF_2 is soluble in water, but undergoes slow hydrolysis. XeF_4 and XeF_6 react violently with water.

15. Xenon hexafluoride reacts with potassium fluoride to yield

- (a) $[\text{XeF}_5]^+ [\text{KF}_2]^-$ (b) $\text{K}^+ [\text{XeF}_7]^-$
(c) XeF_4 (d) none of these.

16. A fluoride of xenon (A) on hydrolysis gives a compound (B) which has trigonal pyramidal structure. (A) and (B) are respectively
- (a) XeF_2 , XeO_2F_2 (b) XeF_6 , XeO_3
 (c) XeF_4 , XeOF_4 (d) XeF_2 , XeO_4

SECTION 4

- This section contains **THREE (03)** questions.
- The answer to each question is a **NON-NEGATIVE INTEGER**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If **ONLY** the correct integer is entered;

Zero Marks : 0 In all other cases.

17. If C – C bond length is 1.54 Å, X–X bond length is 1.00 Å and electronegativity values of C and X are 2.0 and 3.0 respectively then the bond length (in Å) of C – X bond is _____.
18. One mole of AO_2^- is oxidised to A^{n+} in acidic solutions by 0.4 mol of permanganate. The value of n in A^{n+} is _____.
19. Among the given polymers, the number of three-dimensional network polymers is _____.
 HDP, Bakelite, Glycogen, LDP, Polyesters, Urea-formaldehyde polymers, Nylons.

SOLUTIONS

PAPER - I

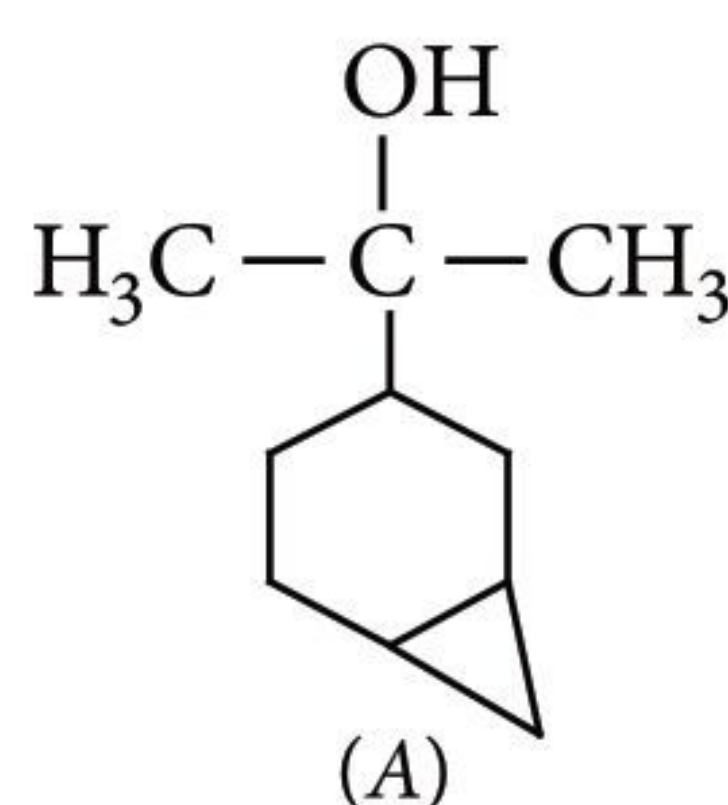
1. (b) : $\Delta x \geq \frac{h}{(4\pi)(\Delta mv)}$

$$\Delta x \geq \frac{6.626 \times 10^{-34}}{(4 \times 3.14 \times 1050)(0.9) \left(\frac{1}{3600} \right) \left(\frac{1000}{1} \right)}$$

$$\Delta x \geq 2 \times 10^{-37} \text{ m}$$

2. (a) : Degree of unsaturation of $\text{C}_{10}\text{H}_{18}\text{O} = 2$, but it contains no double or triple bond.

Hence there are two rings – one six membered as indicated by product and the other three membered which is cleaved by HCl due to strain.



3. (d) : All are ionic solids.

$\text{XeF}_{6(s)}$ consists of XeF_5^+ and F^- ions

$\text{PBr}_{5(s)}$ consists of PBr_4^+ and Br^- ions

$\text{CaC}_{2(s)}$ consists of Ca^{2+} and C_2^{2-} ions

4. (a) : In liquid form,

$$(10.0 \text{ m}^3) \left(\frac{415 \text{ kg}}{\text{m}^3} \right) \left(\frac{1000 \text{ mol}}{16.0 \text{ kg}} \right) = 2.59 \times 10^5 \text{ mol}$$

In gaseous form : $V = \frac{nRT}{P}$

$$= \frac{(2.59 \times 10^5 \text{ mol}) (0.0821 \text{ L atm/mol.K}) (293 \text{ K})}{1.00 \text{ atm}}$$

$$= 6.23 \times 10^6 \text{ L} = 6230 \text{ m}^3$$

5. (10.85) : $\text{Zn} + \text{Fe}^{2+} \longrightarrow \text{Fe} + \text{Zn}^{2+}$

$$E = E^\circ - \frac{0.0591}{n} \log K_c$$

Given $E = 0.2905 \text{ V}$

$$\text{i.e., } 0.2905 = E^\circ - \frac{0.059}{2} \log \left(\frac{0.01}{0.001} \right)$$

$$\begin{aligned} \text{or, } E^\circ &= 0.2905 + 0.0295 \log 10 \\ &= 0.2905 + 0.0295 \quad (\because \log 10 = 1) \\ &= 0.32 \end{aligned}$$

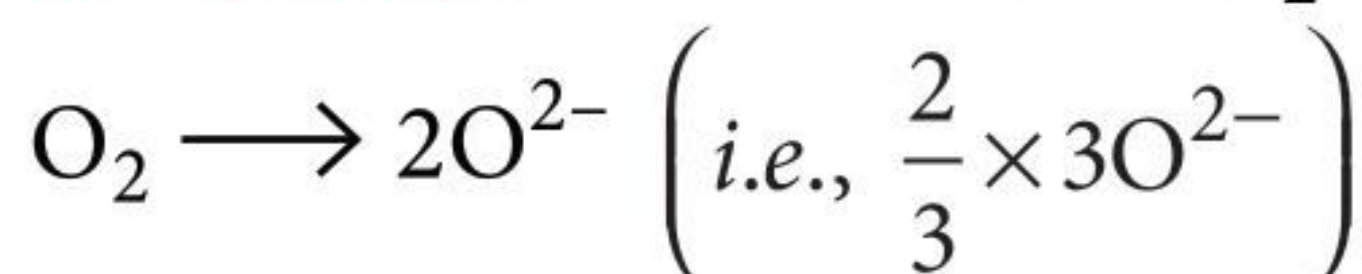
$$E^\circ = \frac{0.0591}{n} \log K_{eq}$$

$$\text{or } 0.32 = \frac{0.0591}{2} \log K_{eq}$$

$$\therefore K_{eq} = 10^{0.32/0.0295} = 10^{10.85}$$

Hence $x = 10.85$

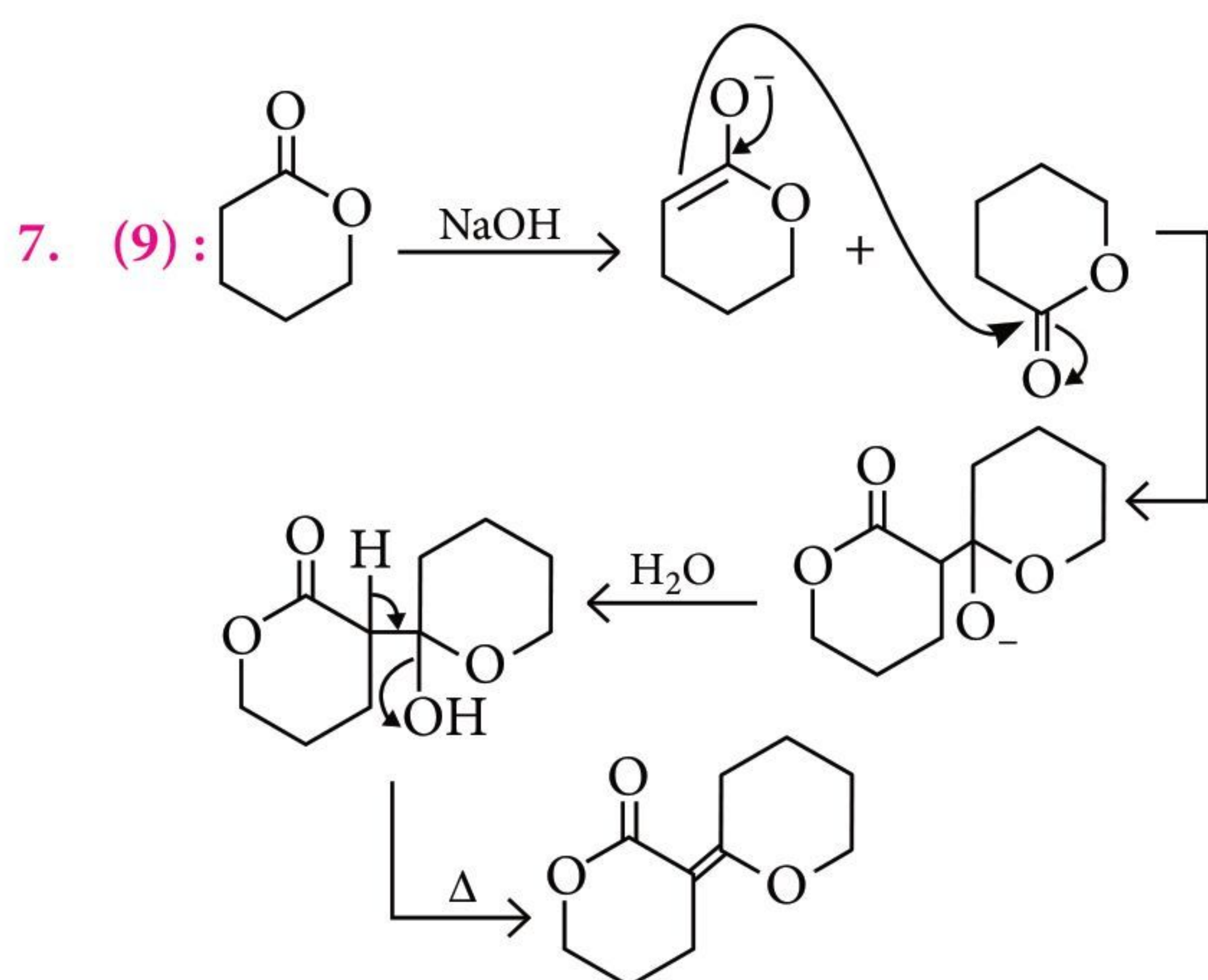
6. (2.14) : For 1 mole of O_2



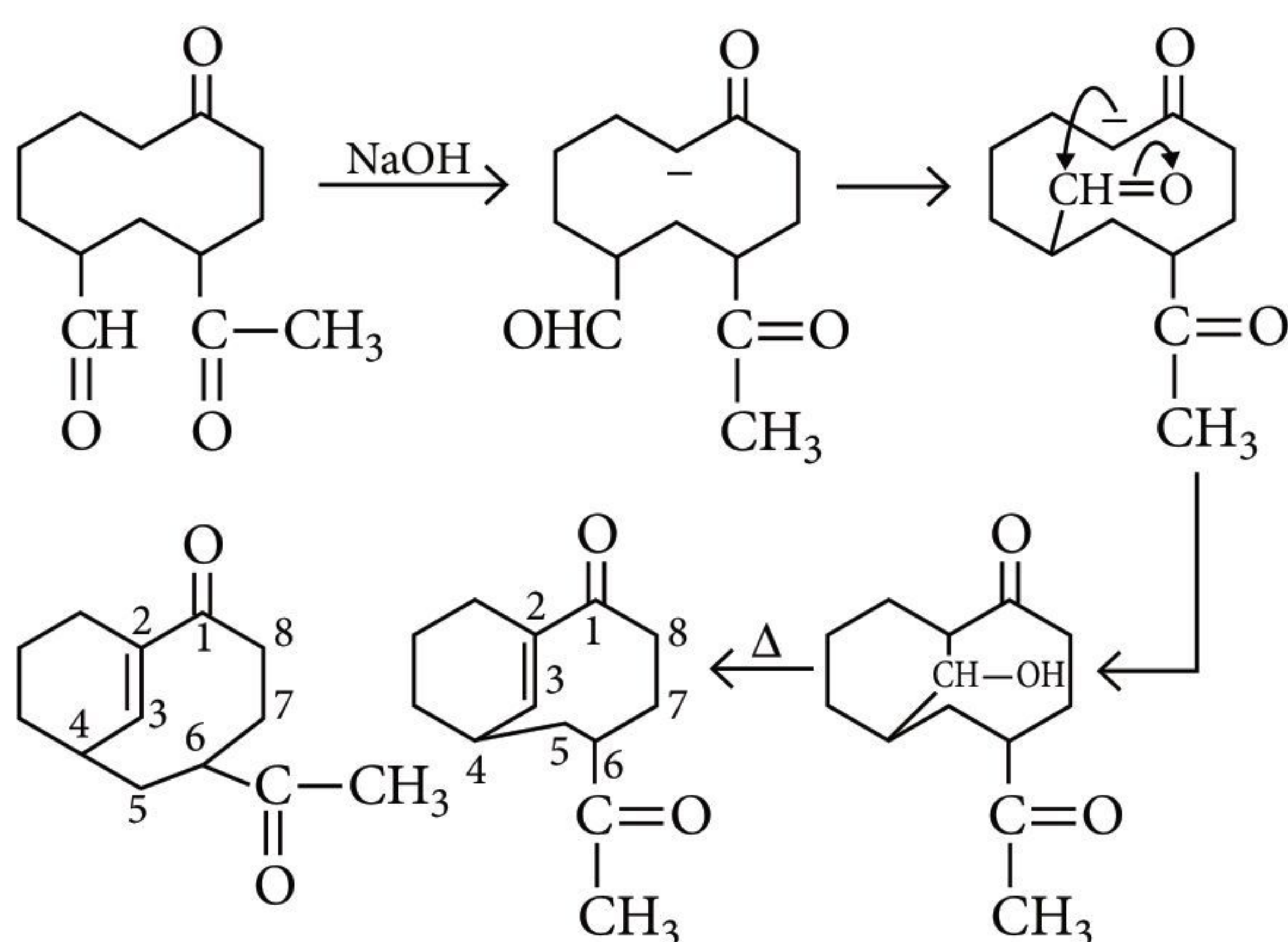
4 mol of Al change into Al^{3+} ions.

$\therefore n = 4$. Thus, $\Delta G = -nFE$

$$E = -\frac{\Delta G}{nF} = -\left(\frac{-827000}{4 \times 96500} \right) = 2.14 \text{ volt}$$



8. (8):



9. (2.5): Molecular orbital configuration of O_2^+ is $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2, \pi 2p_y^2, \pi^* 2p_x^1$. Bond order = $\frac{1}{2} [\text{bonding electrons} - \text{antibonding electrons}] = \frac{1}{2} [10 - 5] = \frac{5}{2} = 2.5$

10. (7.5)

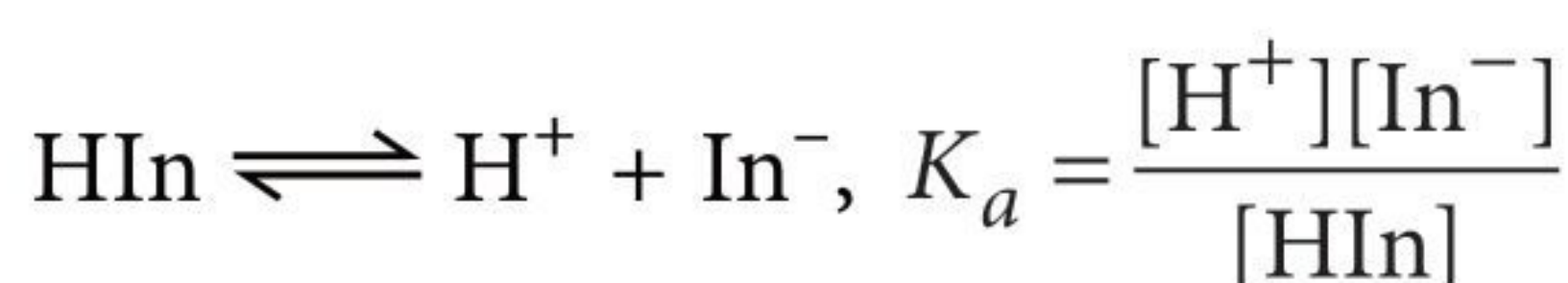
11. (b, d): For figure (1), the rate of formation of B is higher than rate of formation of C. Hence $k_1 \gg k_2$. For figure (2), the rate of formation of C is greater than rate of formation of B. Hence $k_2 > k_1$

12. (a, b, c, d)

13. (c)

14. (b, d)

15. (a, d): For an indicator,



$$\text{So, } [H^+] = K_a \frac{[HIn]}{[In^-]} \text{ or } pH = pK_a + \log \frac{[In^-]}{[HIn]}$$

$$\text{or } 9.6 = 9.0 + \log \frac{[In^-]}{[HIn]} \text{ or } \log 4 = \log \frac{[In^-]}{[HIn]}$$

$$\text{or } \frac{[In^-]}{[HIn]} = 4$$

So, % of $[In^-] = 80\%$, % of $[HIn] = 20\%$.

16. (b, d): P_4O_{10} does not contain P—P bonds rather there are $P \begin{smallmatrix} \diagup O \diagdown \end{smallmatrix} P$ bond.

17. (1): In (Q), i.e., XeO_3 , there are 3 π -bonds and Xe is sp^3 hybridised. XeO_3 has in all 7 electron pairs around Xe, out of which there is 1 lone pair.

18. (2)

19. (5): For initial solution $\pi = \frac{500}{760} \text{ atm}, T = 283 \text{ K}$

$$\frac{500}{760} \times V_1 = n \times R \times 283 \quad \dots(i)$$

After dilution, let volume becomes V_2 and temperature is raised to 25°C i.e., 298 K .

$$\pi = \frac{105.3}{760} \text{ atm}$$

$$\frac{105.3}{760} \times V_2 = n \times R \times 298 \quad \dots(ii)$$

From equation (i) and (ii)

$$\frac{V_1}{V_2} = \frac{283}{298} \times \frac{105.3}{500}; \frac{V_1}{V_2} \approx \frac{1}{5} \Rightarrow V_2 = 5V_1$$

Solution was diluted to 5 times.

PAPER - II

1. (d): No. of sub-shells in n^{th} shell = 0 to $n-1$.

No. of orbitals in a sub-shell = $2l + 1$. No. of electrons in each orbital = 2. Hence no. of e^- in n^{th} shell

$$l = n - 1$$

$$= \sum_{l=0}^{n-1} 2(2l+1)$$

2. (a, d): $T_c = 30^\circ\text{C} = 303 \text{ K}$

$$T_c = \frac{8a}{27Rb} \text{ and } p_c = \frac{a}{27b^2}$$

$$\Rightarrow p_c = 72 \text{ atm}$$

$$\therefore \frac{T_c}{p_c} = \frac{8b}{R} \text{ or } b = \frac{RT_c}{8p_c}$$

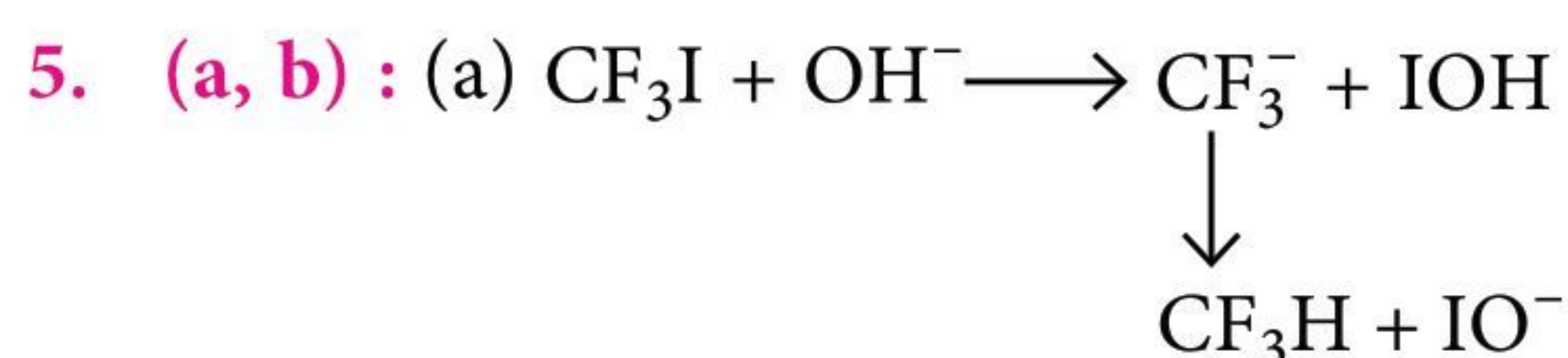
$$\therefore b = \frac{0.0821 \times 303}{8 \times 72} = 0.043 \text{ L mol}^{-1}$$

$$a = 27p_c \times b^2 = 27 \times 72 \times (0.043)^2 = 3.59 \text{ L}^2 \text{ atm mol}^{-2}$$

3. (a) : For II : Transition state is more stabilised than reactant.

For III : Reactants are more stabilised than transition state. Hence, rate of reaction is affected accordingly.

4. (a, d)



(b) $\text{Rb}[\text{ICl}_2] \xrightarrow{\Delta} \text{RbCl} + \text{ICl}$, RbCl is more stable due to high lattice energy so will be the product.

(c) Polymeric silicones are formed.

6. (a, b) : $K_p = K_c (RT)^{\Delta n_g}$

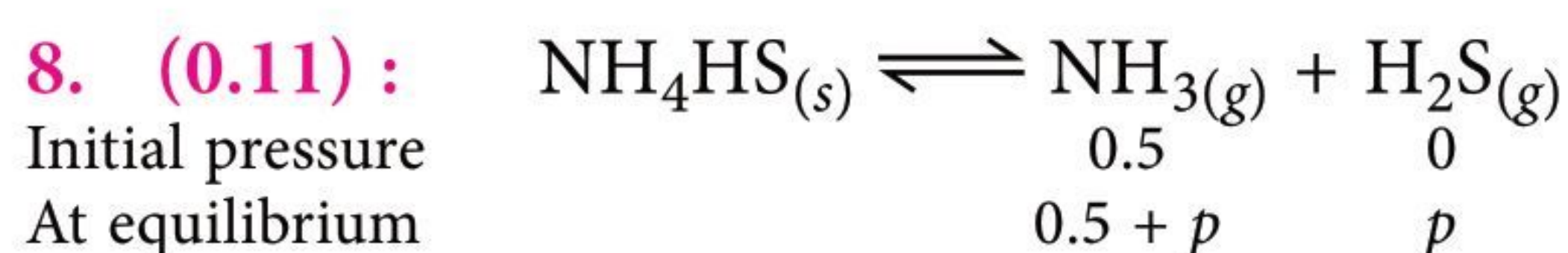
When Δn_g is negative, K_p will be less than K_c .

For (a), $\Delta n_g = -1$; for (b), $\Delta n_g = -2$

7. (0.5) : In Haber process, $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$

Four moles of reactants form two moles of NH_3 .

\therefore Volume of NH_3 relative to the total volume of reactants is half.



$$0.5 + p + p = 0.84 \text{ atm}$$

$$2p = 0.84 - 0.5 = 0.34 \text{ or } p = 0.17 \text{ atm.}$$

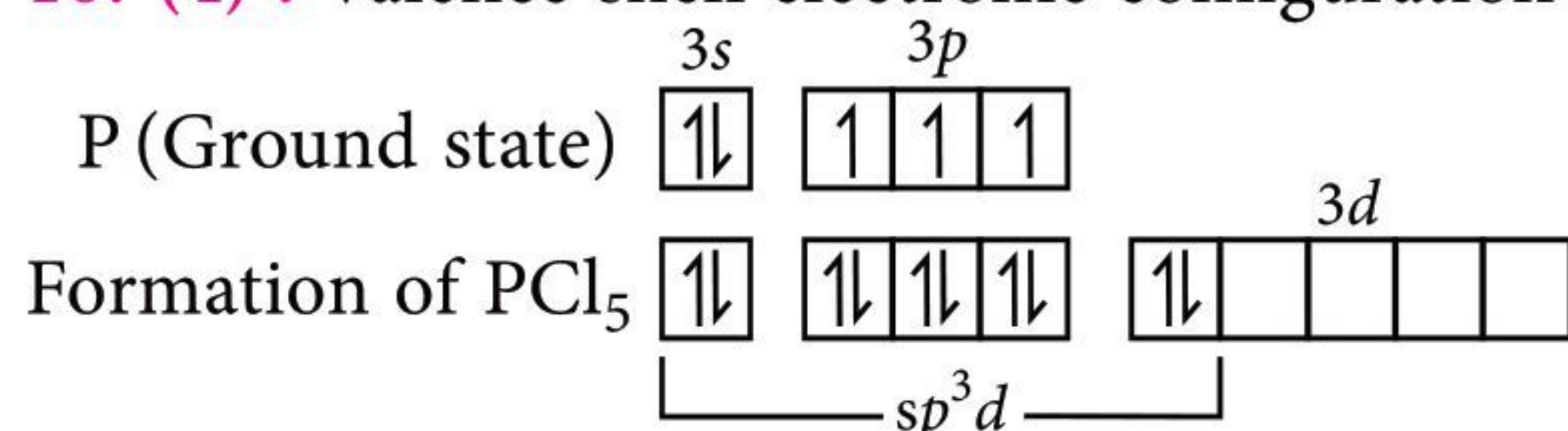
$$p(\text{H}_2\text{S}) = 0.17 \text{ atm,}$$

$$p(\text{NH}_3) = 0.5 + 0.17 = 0.67 \text{ atm}$$

$$K_p = p(\text{NH}_3) \times p(\text{H}_2\text{S}) = 0.67 \times 0.17 = 0.11 \text{ atm}^2.$$

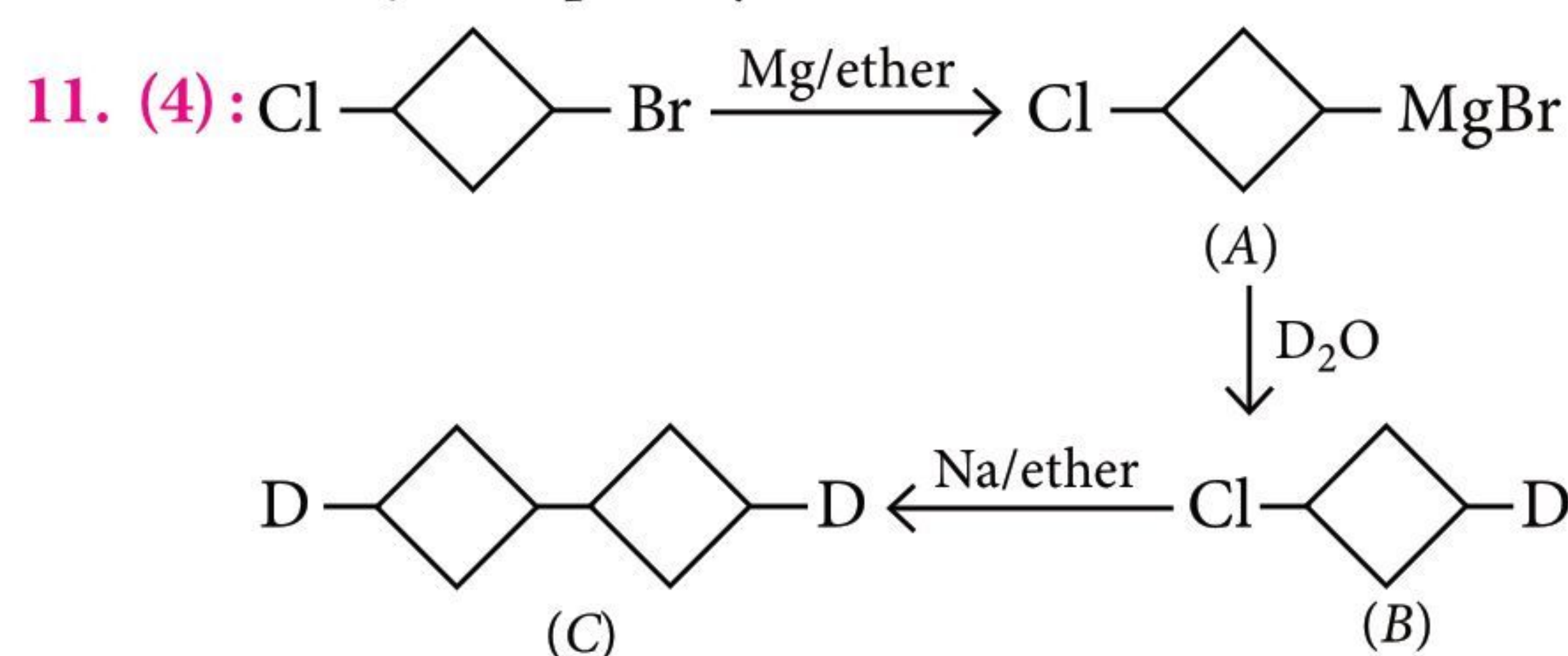
9. (3) : Due to inert pair effect Bi shows only +3 oxidation state.

10. (4) : Valence shell electronic configuration of



Formation of PCl_5

\therefore P in PCl_5 has sp^3d -hybridisation.

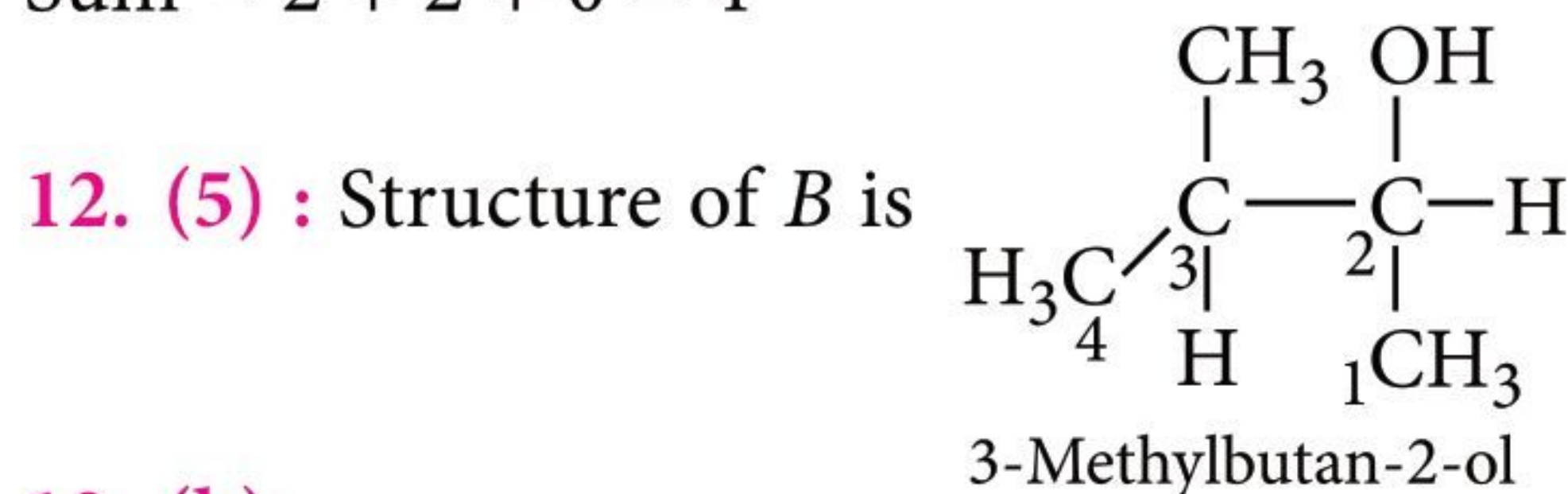


Number of four membered rings = 2

Number of five membered rings = 0

Number of deuterium atoms = 2

$$\text{Sum} = 2 + 2 + 0 = 4$$



13. (b)

14. (a) : Taking logarithm of Arrhenius equation, we get

$$\ln k = \ln A - \frac{E_a}{RT} \text{ or } \log A = \log k + \frac{E_a}{2.303RT}$$

The rate law equation is written as :

$$R = k[A]^2[B]$$

Substituting the values of A, B and Rate (R) at 300 K from first experimental data, we obtain,

$$k = 2.67 \times 10^8$$

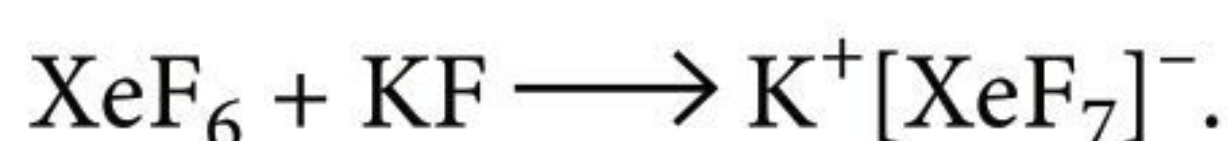
Substituting the first data, we get

$$\log A = \log(2.67 \times 10^8) + \frac{5.533 \times 10^4 \text{ J mol}^{-1}}{2.303 \times 8.314 \text{ J K}^{-1} \text{ mol}^{-1} \times 300 \text{ K}}$$

$$= 8.4265 + 9.6324 = 18.0589$$

$$\text{or } A = 1.145 \times 10^{18} \text{ M}^{-2} \text{ s}^{-1}.$$

15. (b) : KF is a fluoride ion donor, hence it reacts with XeF_6 to give a fluoroanion.



16. (b) : $\text{XeF}_6 + 3\text{H}_2\text{O} \longrightarrow \text{XeO}_3 + 6\text{HF}$

XeO_3 has trigonal pyramidal shape.

17. (1.18)

18. (5) : In a redox reaction, the product of number of moles and change in oxidation number is same for oxidant and reductant.

The change in oxidation number of Mn is 5

The change in oxidation number of A say x.

$$(0.4 \text{ mol}) (5) = (1 \text{ mol}) (x); x = 2$$

It is oxidised to A^{n+} , where the increase in the oxidation number is 2.

$$\therefore n = +3 + 2 = +5$$

19. (2)

MONTHLY TEST DRIVE CLASS XI ANSWER KEY

1. (b)	2. (b)	3. (d)	4. (c)	5. (c)
6. (c)	7. (c)	8. (b)	9. (d)	10. (d)
11. (d)	12. (d)	13. (d)	14. (c)	15. (c)
16. (d)	17. (b)	18. (c)	19. (b)	20. (a,c)
21. (a,d)	22. (b,c,d)	23. (a,c)	24. (4)	25. (4)
26. (7)	27. (a)	28. (b)	29. (d)	30. (a)





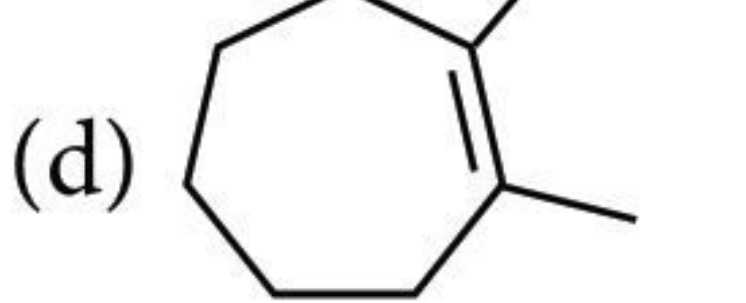
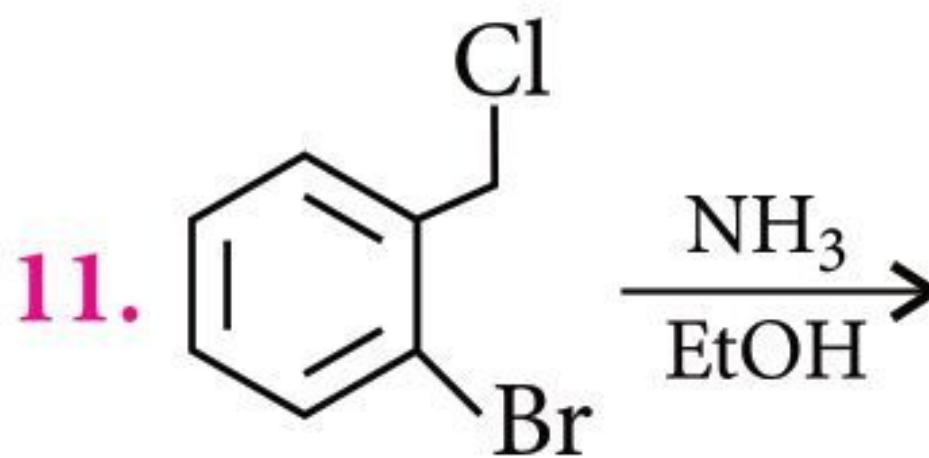
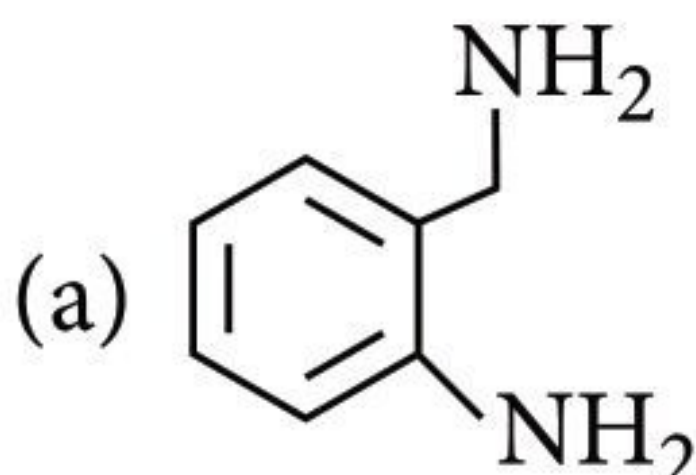
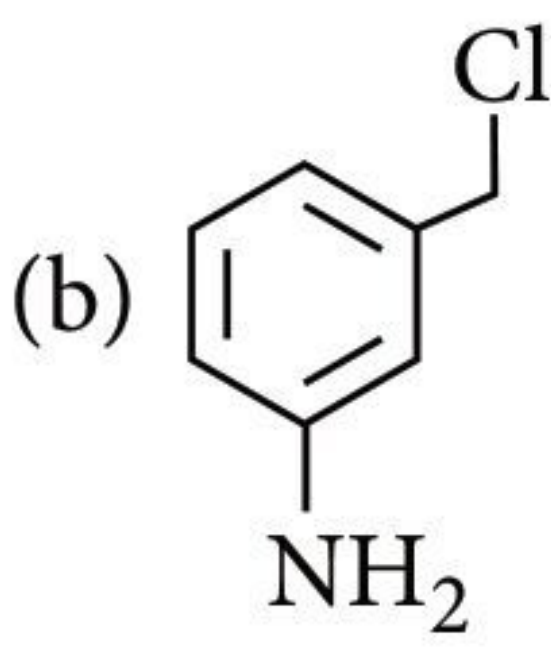
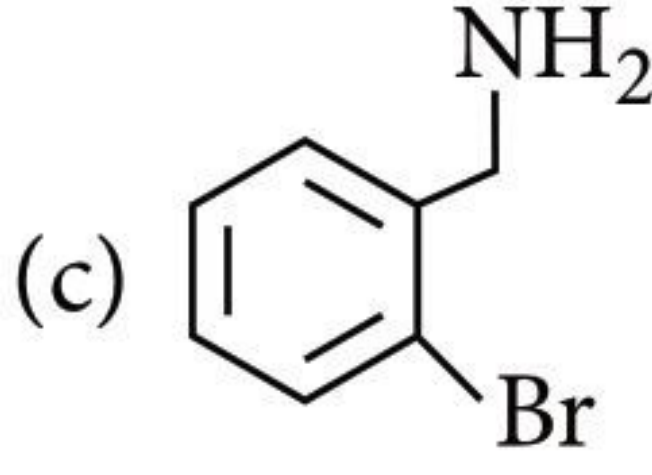
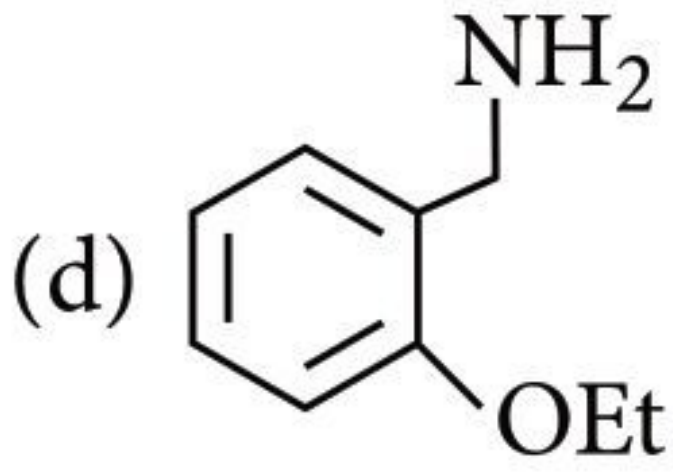
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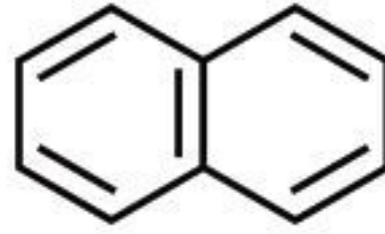

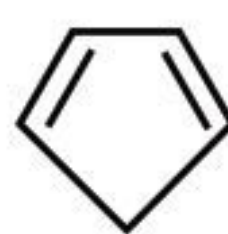

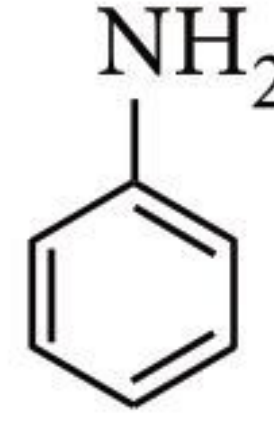
NEET 2022

Exam on
17th July 2022

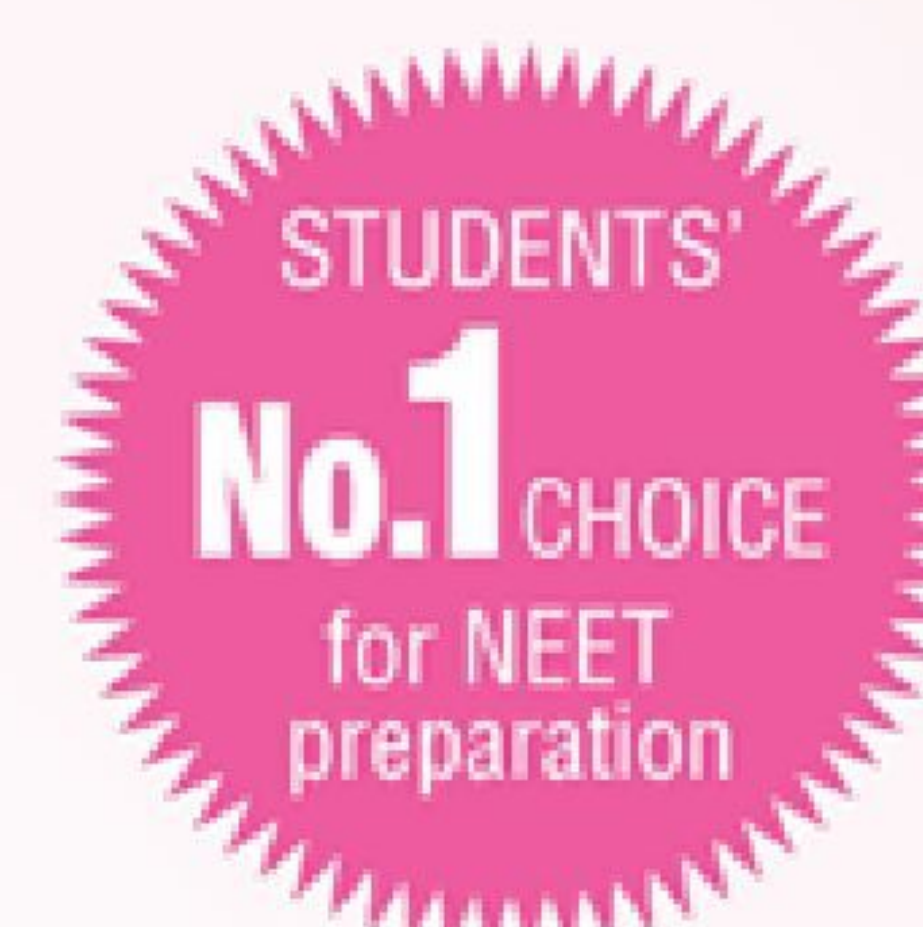
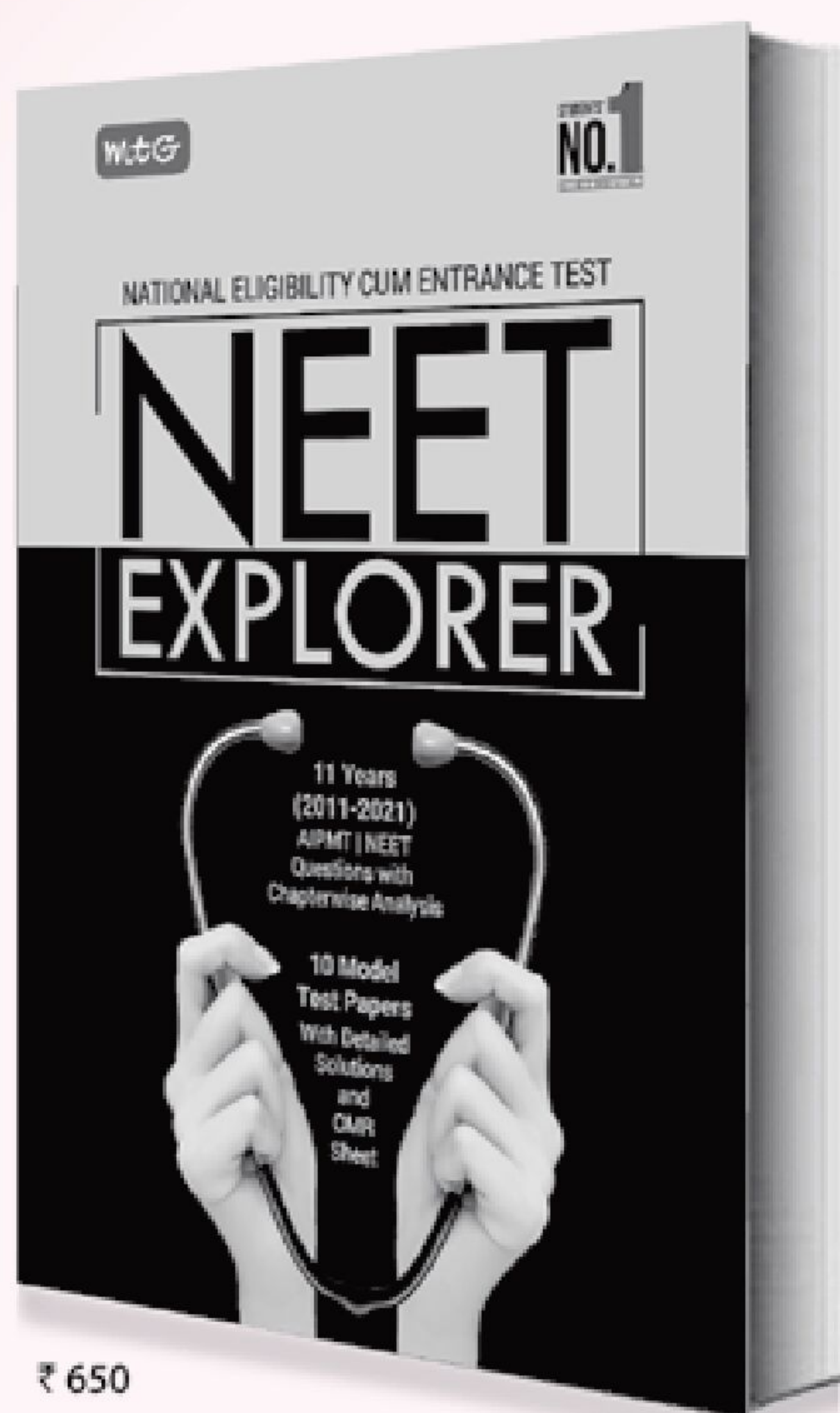


SECTION - A

- The molality of the 3 M solution of methanol if the density of the solution is 0.9 g cm^{-3} is
(a) 3.73 (b) 3.0 (c) 3.33 (d) 3.1
- The number of angular and radial nodes in 3p orbital respectively are
(a) 3, 1 (b) 1, 1 (c) 2, 1 (d) 2, 3
- Which of the following is not isomorphous with true alums and is called pseudoalums?
(a) $\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$
(b) $\text{FeSO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$
(c) $\text{K}_2\text{SO}_4 \cdot \text{Cr}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$
(d) $(\text{NH}_4)_2\text{SO}_4 \cdot \text{Fe}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$
- In which pair of ions both the species contain S — S bond?
(a) $\text{S}_4\text{O}_6^{2-}$, $\text{S}_2\text{O}_3^{2-}$ (b) $\text{S}_2\text{O}_7^{2-}$, $\text{S}_2\text{O}_8^{2-}$
(c) $\text{S}_4\text{O}_6^{2-}$, $\text{S}_2\text{O}_7^{2-}$ (d) $\text{S}_2\text{O}_7^{2-}$, $\text{S}_2\text{O}_3^{2-}$
- The manganate and permanganate ions are tetrahedral, due to
(a) the π -bonding involves overlap of d -orbitals of oxygen with d -orbitals of manganese
(b) the π -bonding involves overlap of p -orbitals of oxygen with d -orbitals of manganese
(c) there is no π -bonding
(d) the π -bonding involves overlap of p -orbitals of oxygen with p -orbitals of manganese.
- Which of the following has longest C — O bond length? (Free C — O bond length in CO is 1.128 \AA .)
(a) $[\text{Fe}(\text{CO})_4]^{2-}$ (b) $[\text{Mn}(\text{CO})_6]^+$
(c) $\text{Ni}(\text{CO})_4$ (d) $[\text{Co}(\text{CO})_4]^-$
- The maximum number of possible optical isomers in 1-bromo-2-methylcyclobutane is
(a) 4 (b) 2 (c) 8 (d) 16
- The following alcohol after treatment with acid gives compound A. Ozonolysis of A gives nonane-2, 8-dione. The compound A is

(a)  (b) 
(c)  (d) 
- Which of the following oxides is the most acidic?
(a) BeO (b) MgO
(c) Al_2O_3 (d) Cl_2O_7
- Consider the following species,
1. $[\text{O}_2]^{2-}$ 2. $[\text{CO}]^+$ 3. $[\text{O}_2]^+$
Among these, only sigma bond alone is present in
(a) 1 (b) 2
(c) 3 (d) 1 and 2
- 
The product of the above reaction is
(a)  (b) 
(c)  (d) 

12. If same type of atoms are packed in hexagonal close packing and cubic close packing separately, then
 (a) density of *hcp* will be greater than *ccp*
 (b) density of *hcp* will be smaller than *ccp*
 (c) density of *hcp* will be equal to *ccp*
 (d) density of *hcp* and *ccp* will depend upon the temperature of the system.
13. The coagulation of 200 mL of a positive colloid took place when 0.73 g HCl was added to it without changing the volume much. The flocculation value of HCl for the colloid is
 (a) 100 (b) 36.5 (c) 0.365 (d) 150
14. Which of the following forces is the strongest?
 (a) Hydrogen bonding (b) Dipole-dipole forces
 (c) van der Waals' forces (d) Co-ordinate bonding
15. Consider the following four electrodes,
 $P = \text{Cu}^{2+} (0.0001 \text{ M}) / \text{Cu}_{(s)}$
 $Q = \text{Cu}^{2+} (0.1 \text{ M}) / \text{Cu}_{(s)}$
 $R = \text{Cu}^{2+} (0.01 \text{ M}) / \text{Cu}_{(s)}$
 $S = \text{Cu}^{2+} (0.001 \text{ M}) / \text{Cu}_{(s)}$
 If the standard reduction potential of Cu^{2+}/Cu is +0.34 V, the reduction potentials in volts of the above electrodes follow the order
 (a) $P > S > R > Q$ (b) $S > R > Q > P$
 (c) $R > S > Q > P$ (d) $Q > R > S > P$
16. The crystal field stabilisation energy (CFSE) for $[\text{CoCl}_6]^{4-}$ is 18000 cm^{-1} . The CFSE for $[\text{CoCl}_4]^{2-}$ will be
 (a) 6000 cm^{-1} (b) 16000 cm^{-1}
 (c) 18000 cm^{-1} (d) 8000 cm^{-1}
17. Of the following 0.10 m aqueous solutions, which one will exhibit the largest freezing point depression?
 (a) KCl (b) $\text{C}_6\text{H}_{12}\text{O}_6$
 (c) $\text{Al}_2(\text{SO}_4)_3$ (d) K_2SO_4
18. Which of the following chemical system is non aromatic?
 (a)  (b) 
 (c)  (d) 
19. 0.833 mole of a carbohydrate with empirical formula CH_2O , has 10 g of hydrogen. Molecular formula of the carbohydrate is
 (a) $\text{C}_3\text{H}_5\text{O}_3$ (b) $\text{C}_6\text{H}_{12}\text{O}_6$
 (c) $\text{C}_3\text{H}_{10}\text{O}_5$ (d) $\text{C}_3\text{H}_4\text{O}_3$
20. The compound A on treatment with Na gives B, and with PCl_5 gives C. B and C react together to give diethyl ether. A, B and C are in the order
 (a) $\text{C}_2\text{H}_5\text{OH}$, C_2H_6 , $\text{C}_2\text{H}_5\text{Cl}$
 (b) $\text{C}_2\text{H}_5\text{OH}$, $\text{C}_2\text{H}_5\text{Cl}$, $\text{C}_2\text{H}_5\text{ONa}$
 (c) $\text{C}_2\text{H}_5\text{Cl}$, C_2H_6 , $\text{C}_2\text{H}_5\text{OH}$
 (d) $\text{C}_2\text{H}_5\text{OH}$, $\text{C}_2\text{H}_5\text{ONa}$, $\text{C}_2\text{H}_5\text{Cl}$
21. The glycosidic linkage involved in linking the glucose units in amylose part of starch is
 (a) $\text{C}_1 - \text{C}_4$ β linkage (b) $\text{C}_1 - \text{C}_6$ α linkage
 (c) $\text{C}_1 - \text{C}_5$ α linkage (d) $\text{C}_1 - \text{C}_4$ α linkage.
22. The correct increasing order of basic strength for the following compounds is
 $\text{C}_2\text{H}_5\text{NHC}_2\text{H}_5$; ; 
 (I) (II) (III)
 (a) $\text{III} < \text{I} < \text{II}$ (b) $\text{III} < \text{II} < \text{I}$
 (c) $\text{I} < \text{II} < \text{III}$ (d) $\text{II} < \text{I} < \text{III}$
23. A gas at high temperature is cooled. The highest temperature at which liquefaction of gas first occurs is called
 (a) Boyle temperature (b) critical temperature
 (c) boiling temperature (d) freezing temperature.
24. E_1 , E_2 and E_3 are the emfs of the following three galvanic cells respectively:
 (i) $\text{Zn}_{(s)} | \text{Zn}^{2+} (0.1 \text{ M}) || \text{Cu}^{2+} (1 \text{ M}) | \text{Cu}_{(s)}$
 (ii) $\text{Zn}_{(s)} | \text{Zn}^{2+} (1 \text{ M}) || \text{Cu}^{2+} (1 \text{ M}) | \text{Cu}_{(s)}$
 (iii) $\text{Zn}_{(s)} | \text{Zn}^{2+} (1 \text{ M}) || \text{Cu}^{2+} (0.1 \text{ M}) | \text{Cu}_{(s)}$
 Which one of the following is true?
 (a) $E_2 > E_1 > E_3$ (b) $E_1 > E_2 > E_3$
 (c) $E_3 > E_1 > E_2$ (d) $E_3 > E_2 > E_1$
25. Sulphur trioxide gas when dissolved in H_2SO_4 , the product obtained is
 (a) H_2SO_3 (b) H_2SO_5
 (c) $\text{H}_2\text{S}_2\text{O}_7$ (d) $\text{H}_2\text{S}_2\text{O}_8$
26. Cryolite is
 (a) Na_3AlF_6 and is used in the electrolysis of alumina for lowering the melting point of alumina only
 (b) Na_3AlF_6 and is used in the electrolytic refining of alumina
 (c) Na_3AlF_6 and is used in the electrolysis of alumina for decreasing electrical conductivity
 (d) Na_3AlF_6 and is used in the electrolysis of alumina for lowering the melting point and increasing the conductivity of alumina.

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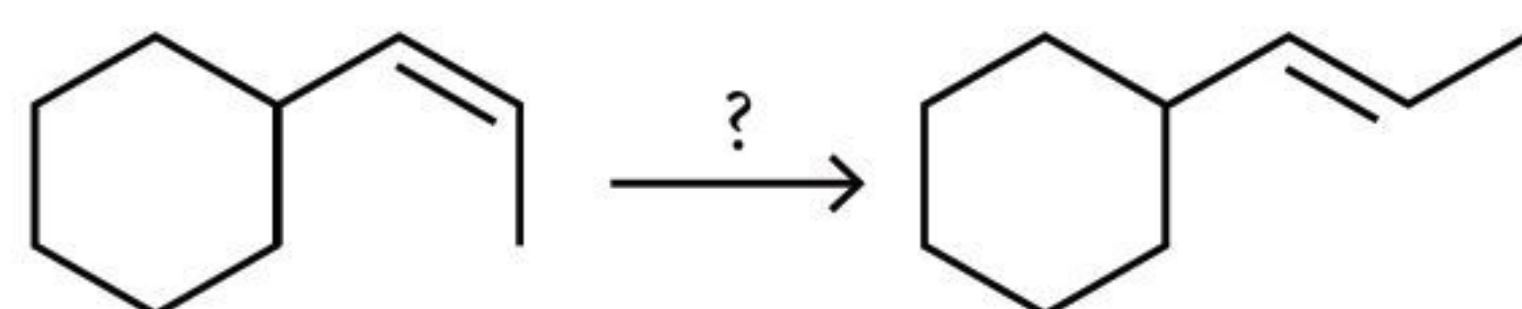


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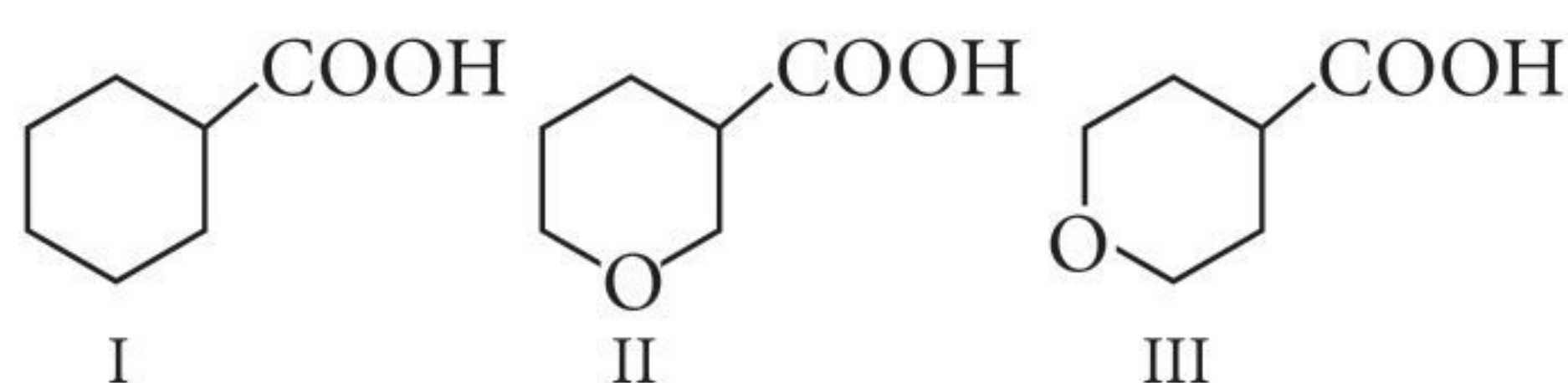
HIGHLIGHTS:

- 10 Model Test Papers based on latest NEET syllabus
- Last 11 years' solved test papers of AIPMT / NEET
- Includes NEET 2021 solved paper
- OMR Sheet provided after each Model Test Paper
- Detailed solutions for self-assessment and to practice time management

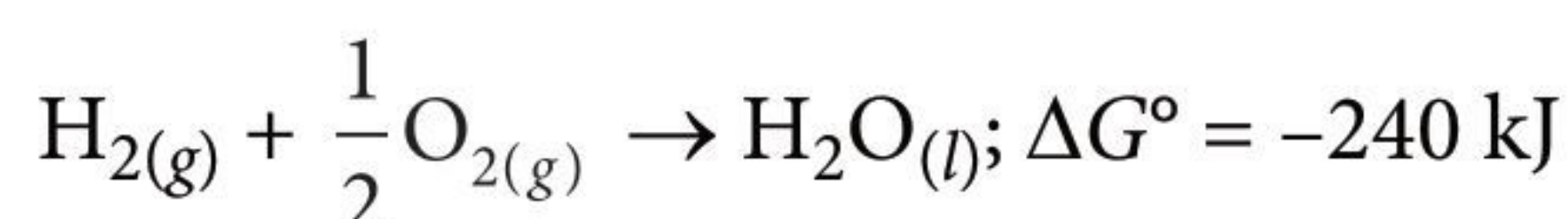
27. Bauxite has the composition
 (a) Al_2O_3 (b) $\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$
 (c) $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ (d) none of these.
28. Ethyl benzene cannot be prepared by
 (a) Wurtz reaction
 (b) Wurtz-Fittig reaction
 (c) Friedel-Crafts reaction
 (d) Clemmensen reduction.
29. The boiling point of *p*-nitrophenol is higher than that of *o*-nitrophenol because
 (a) intramolecular hydrogen bonding exists in *p*-nitrophenol
 (b) $-\text{NO}_2$ group at *p*-position behaves in a different way from that at *o*-position.
 (c) *p*-nitrophenol has a higher molecular weight than *o*-nitrophenol
 (d) there is intermolecular hydrogen bonding in *p*-nitrophenol.
30. What is the correct sequence of reagents for the following preparations?



- (a) HBr, Alc. KOH, NaNH_2 , liq. NH_3
 (b) Alc. KOH, liq. NH_3 , HBr, NaNH_2
 (c) liq. NH_3 , alc. KOH, HBr, NaNH_2
 (d) HBr, liq. NH_3 , alc. KOH, NaNH_2
31. The correct order of strengths of the carboxylic acids is



- (a) $\text{I} > \text{II} > \text{III}$ (b) $\text{II} > \text{III} > \text{I}$
 (c) $\text{III} > \text{II} > \text{I}$ (d) $\text{II} > \text{I} > \text{III}$
32. In the solid state PCl_5 exists as
 (a) $[\text{PCl}_4]^-$ and $[\text{PCl}_6]^+$ ions
 (b) covalent PCl_5 molecules only
 (c) $[\text{PCl}_4]^+$ and $[\text{PCl}_6]^-$ ions
 (d) covalent P_2Cl_{10} molecules only.
33. For hydrogen-oxygen fuel cell at one atm and 298 K

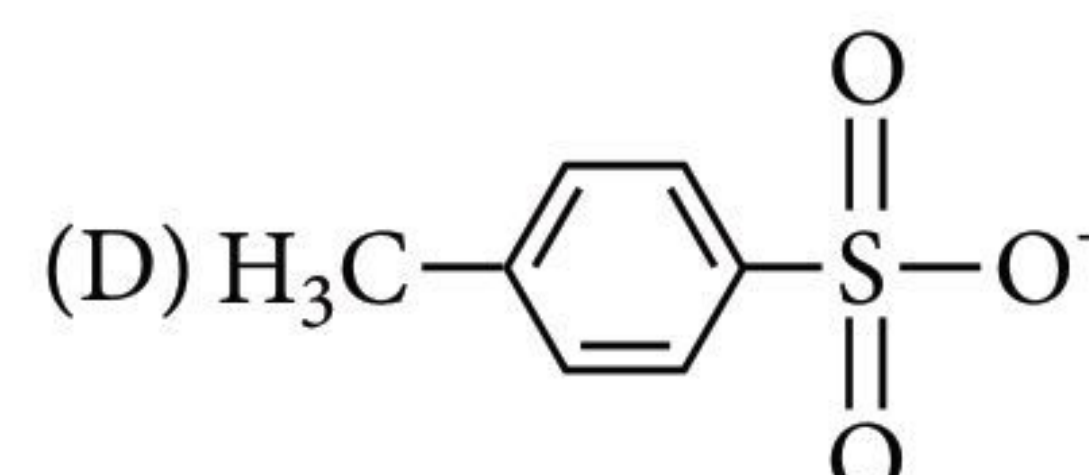
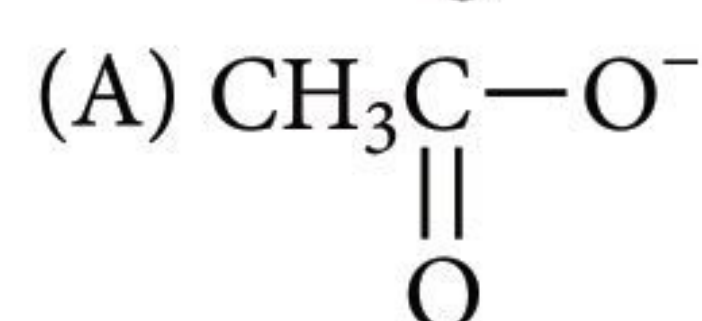


E° for the cell is approximately,

(Given : $F = 96,500 \text{ C}$)

- (a) 2.48 V (b) 1.24 V (c) 2.5 V (d) 1.26 V

34. In a zero-order reaction, for every 10°C rise of temperature, the rate is doubled. If the temperature is increased from 10°C to 100°C , the rate of the reaction will become
 (a) 256 times (b) 512 times
 (c) 64 times (d) 128 times.
35. Arrange the following nucleophiles in the decreasing order of nucleophilicity :



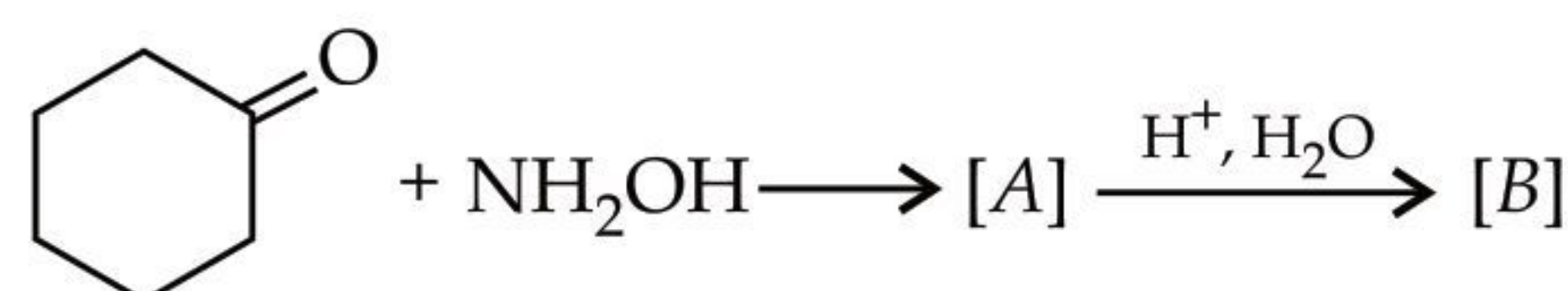
- (a) C, B, A, D
 (c) D, C, B, A

- (b) A, B, C, D
 (d) B, C, A, D

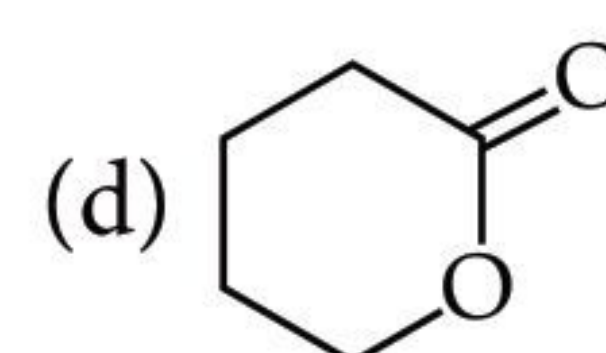
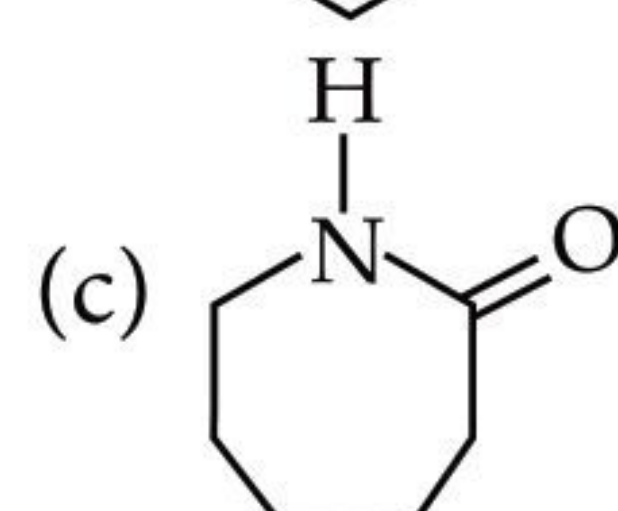
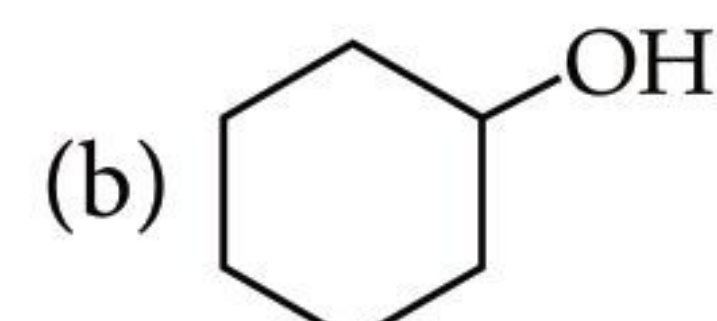
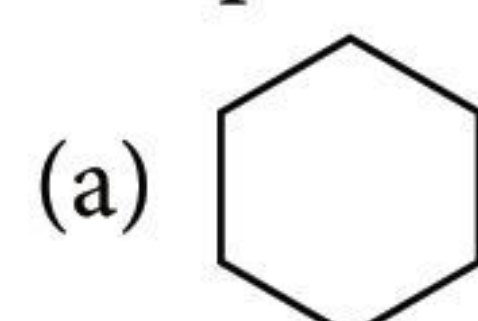
SECTION - B

Attempt any 10 questions out of 15.

36. Arrange the acids (I) H_2SO_4 , (II) H_3PO_3 , and (III) HClO_4 in the decreasing order of acidity.
 (a) $\text{I} > \text{III} > \text{II}$ (b) $\text{I} > \text{II} > \text{III}$
 (c) $\text{III} > \text{I} > \text{II}$ (d) $\text{II} > \text{III} > \text{I}$
37. Which of the following gases has the highest value of *rms* velocity at 298 K?
 (a) CH_4 (b) CO (c) Cl_2 (d) CO_2
38. In the reaction,

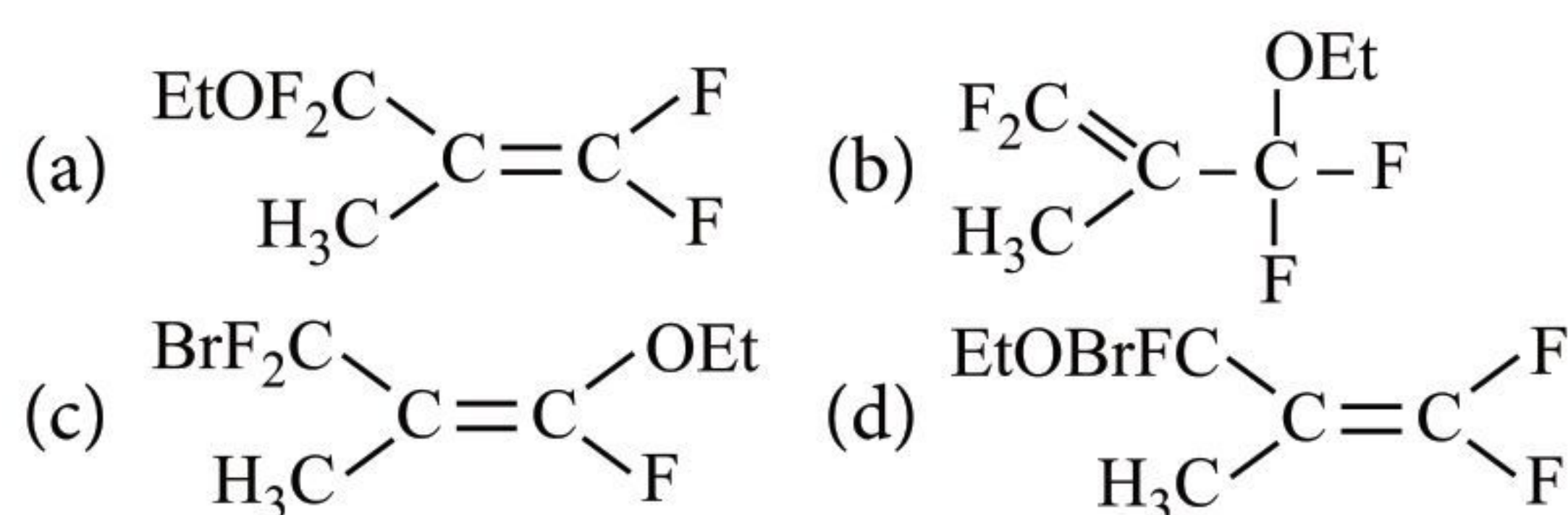


The product B is



39. In hexagonal close packing of spheres in three-dimensions
 (a) in one unit cell there are 12 octahedral voids and all are completely inside the unit cell
 (b) in one unit cell there are six octahedral voids and all are completely inside the unit cell
 (c) in one unit cell there are six octahedral voids out of which three are completely inside the unit cell and other three are from contributions of octahedral voids which are partially inside the unit cell
 (d) in one unit cell there are 6 tetrahedral voids, all are completely inside the unit cell.

40. $\text{BrF}_2\text{C}=\text{C}(\text{F})\text{CH}_3 \xrightarrow{\text{CH}_3\text{CH}_2\text{O}^- (\text{1eq})} [\text{X}]$ major product is



41. In carbon monoxide molecule, carbon and oxygen are linked by

- (a) only σ -bonds (b) only π -bonds
 (c) σ as well as π -bonds (d) none of these.

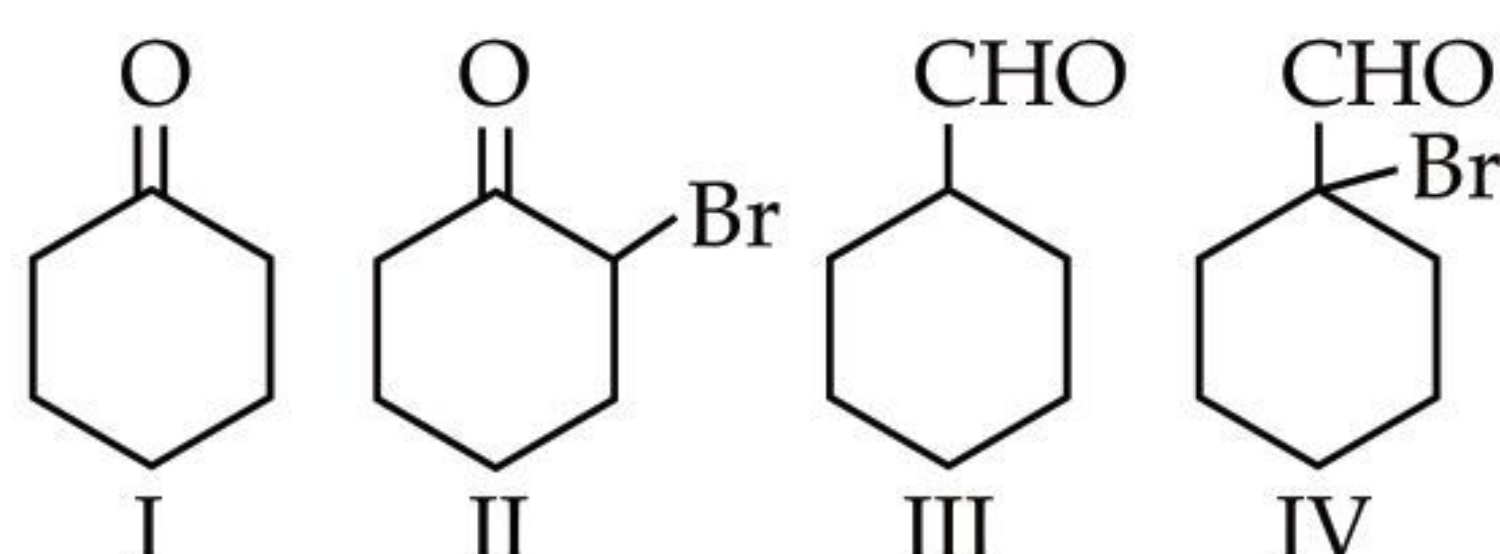
42. Which is not correct?

- (a) $\text{Ge}(\text{OH})_2$ is amphoteric.
 (b) GeCl_2 is more stable than GeCl_4 .
 (c) GeO_2 is weakly acidic.
 (d) GeCl_4 in HCl forms $[\text{GeCl}_6]^{2-}$ ion.

43. 60 g of water gas and 18 g of steam are heated in a closed vessel to a temperature of 450°C so that the equilibrium : $\text{CO}_{(g)} + \text{H}_2\text{O}_{(g)} \rightleftharpoons \text{CO}_{2(g)} + \text{H}_{2(g)}$ is reached. If K for the reaction is 3, the mass of CO_2 present will be

- (a) 11 g (b) 22 g (c) 44 g (d) 60 g

44. Arrange the following in increasing extent of hydration.

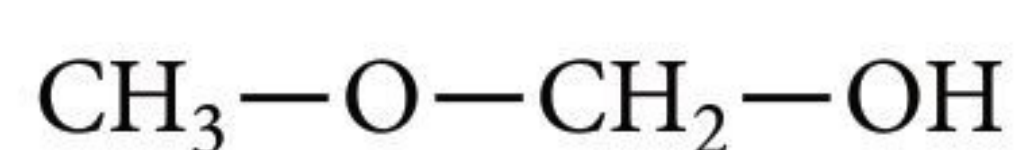


- (a) $\text{I} > \text{II} > \text{III} > \text{IV}$ (b) $\text{I} > \text{II} > \text{IV} > \text{III}$
 (c) $\text{II} > \text{I} > \text{IV} > \text{III}$ (d) $\text{IV} > \text{III} > \text{II} > \text{I}$

45. PCl_5 is reactive because

- (a) it has 5 P – Cl bonds
 (b) in its geometry, the axial bonds are longer and weaker than equatorial bonds
 (c) it is a planar molecule
 (d) P involves one d -orbital in its hybridisation.

46. $\text{CH}_3-\text{O}-\text{CH}_2-\text{Cl} \xrightarrow[\Delta]{\text{aq. OH}^-}$



Which information below regarding this reaction is applicable?

- (a) It follows $\text{S}_{\text{N}}2$ pathway, because it is a primary alkyl chloride.

- (b) It follows $\text{S}_{\text{N}}1$ pathway, because the intermediate carbocation is resonance stabilized.

- (c) $\text{S}_{\text{N}}1$ pathway is not followed, because the intermediate carbocation is destabilised by $-I$ effect of oxygen.

- (d) A mixed $\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$ pathway is followed.

47. The exact order of boiling points of the compounds n -pentane, isopentane, butanone and 1-butanol is

- (a) n -pentane < isopentane < butanone < 1-butanol
 (b) isopentane < n -pentane < butanone < 1-butanol
 (c) butanone < n -pentane < isopentane < 1-butanol
 (d) 1-butanol < butanone < n -pentane < isopentane.

48. Which one of the following is a polyamide polymer?

- (a) Terylene (b) Nylon-6,6
 (c) Buna-S (d) Bakelite

49. The correct statement about ICl_5 and ICl_4^- is

- (a) both are isostructural
 (b) ICl_5 is square pyramidal and ICl_4^- is square planar
 (c) ICl_5 is trigonal bipyramidal and ICl_4^- is tetrahedral
 (d) ICl_5 is square pyramidal and ICl_4^- is tetrahedral.

50. Match the refining methods (Column I) with metals (Column II).

Column I (Refining methods)	Column II (Metals)
(I) Liquation	(A) Zr
(II) Zone refining	(B) Ni
(III) Mond process	(C) Sn
(IV) van Arkel method	(D) Ga
(a) (I) - (C); (II) - (A); (III) - (B); (IV) - (D)	
(b) (I) - (B); (II) - (C); (III) - (D); (IV) - (A)	
(c) (I) - (B); (II) - (D); (III) - (A); (IV) - (C)	
(d) (I) - (C); (II) - (D); (III) - (B); (IV) - (A)	

SOLUTIONS

1. (a): Number of moles of methanol = 3 mol

Molar mass of methanol = 32 g/mol

Mass of methanol present in solution = 96 g

Volume of solution = 1000 mL

Density of solution = 0.9 g cm^{-3}

Mass of solution = $0.9 \times 100 = 900 \text{ g}$

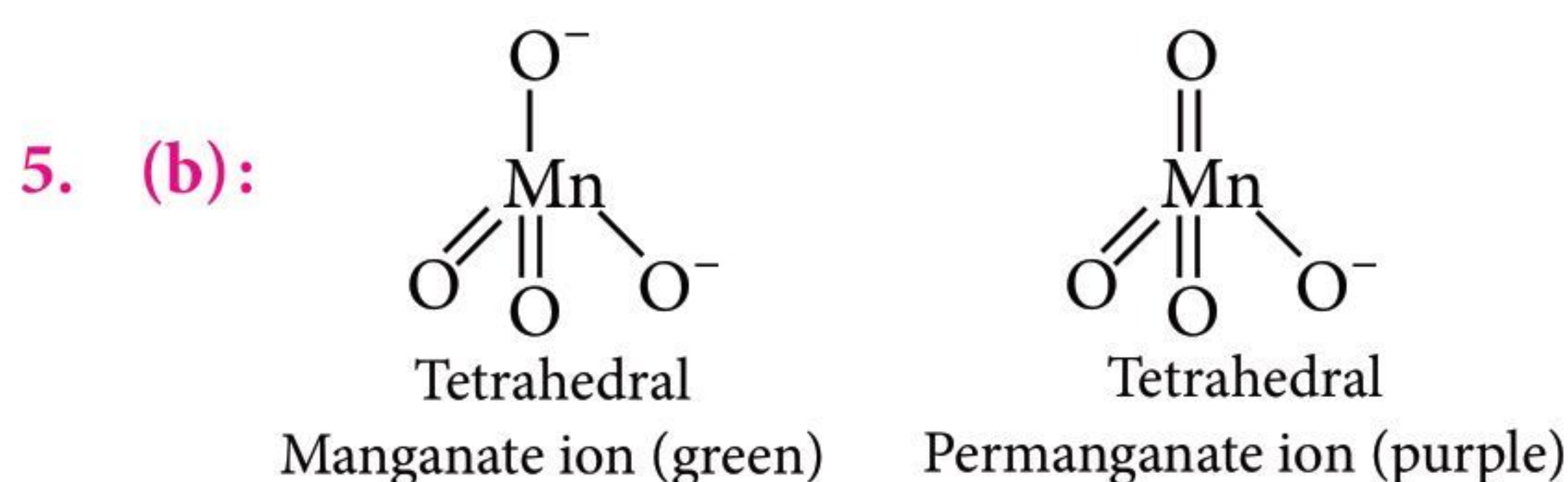
Mass of solvent = $900 - 96 = 804 \text{ g}$ or 0.804 kg

Molality (m) = $\frac{\text{Number of moles of methanol}}{\text{Mass of solvent (kg)}}$

$$= \frac{3}{0.804} = 3.73 \text{ mol / kg}$$

$$\text{No. of radial nodes} = n - l - 1 = 3 - 1 - 1 = 1$$

4. (a): $\bar{\text{O}}-\text{S}(=\text{O})_2-\text{S}-\text{S}-\text{S}(=\text{O})_2-\text{O}^-$ $\text{S}(=\text{O})_2-\text{O}^-$
 $(\text{S}_4\text{O}_6^{2-})$ $(\text{S}_2\text{O}_3^{2-})$



6. (a): The greater the negative charge on the carbonyl complex, the more easy it would be for the metal to permit its electrons to participate in the back bonding, the higher would be the $M - C$ bond order and simultaneously there would be larger reduction in the $C - O$ bond order. Thus, $[\text{Fe}(\text{CO})_4]^{2-}$ has the lowest $C - O$ bond order means the longest bond length.

The number of meso forms, $m = 0$


8. (d):


Reaction scheme showing the conversion of 1,1-dimethylcyclohexanol to nonane-2,8-dione:

1,1-dimethylcyclohexanol reacts with H^+ to form a protonated intermediate. This intermediate loses H_2O to form a carbocation. The carbocation undergoes ring expansion to form a seven-membered ring carbocation. Loss of H^+ yields 1,1-dimethylcycloheptene. Ozonolysis (O_3) of 1,1-dimethylcycloheptene yields nonane-2,8-dione ($\text{CH}_3\text{C}(=\text{O})(\text{CH}_2)_5\text{C}(=\text{O})\text{CH}_3$).

(A)

10. (a): $[\ddot{\text{O}}-\ddot{\text{O}}:]^{2-}$ $[\text{C}\equiv\text{O}]^+$ $[\text{O}\equiv\text{O}]^+$
 O_2^{2-} CO^+ O_2^+

11. (c) : 

∴ Product is 

13. (a): 200 mL of the sol required = 0.73 g HCl

$$= \frac{0.73}{36.5} = 0.02 \text{ mol} = 20 \text{ mmol}$$

$$= \frac{20}{200} \times 1000 = 100 \text{ mmol}$$

14. (d)

15. (d): $E_{\text{red}} = E_{\text{red}}^{\circ} + \frac{0.591}{n} \log[M]^{n+}$

16. (d): $\Delta_t = \frac{4}{9}\Delta_o = \frac{4}{9} \times 18000 = 8000 \text{ cm}^{-1}$



COMIC CAPSULE

Chemistry Professor : Now, class, here I have a beaker of H_2SO_4 , and here I have a gold ring. Suppose I drop the ring into the sulphuric acid. Will the gold dissolve?

Student : No

Professor : Good, And will you please tell us why not?

Student : If it would dissolve, you wouldn't put it in.

17. (c) : $\Delta T_f = i \times K_f \times m$

So, $\Delta T_f \propto i$ (van't Hoff factor)

Salt	i
KCl	2
C ₆ H ₁₂ O ₆	1
Al ₂ (SO ₄) ₃	5
K ₂ SO ₄	3

Hence, i is maximum i.e., 5 for Al₂(SO₄)₃.

18. (d) : The molecules which do not satisfy Huckel rule or $(4n + 2)\pi$ -electron rule are said to be non-aromatic. The compound (d) has total $4\pi e^-$. It does not follow $(4n + 2)$ rule and has a non-planar structure. So it is non-aromatic compound. All other compounds a, b, and c are planar and have $6\pi e^-$, so they are aromatic.

19. (b) : Moles of carbohydrate = 0.833

Weight of hydrogen = 10 g

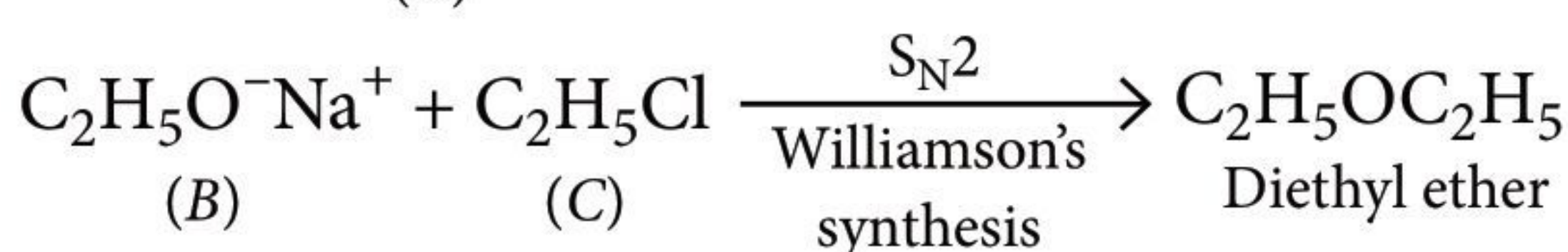
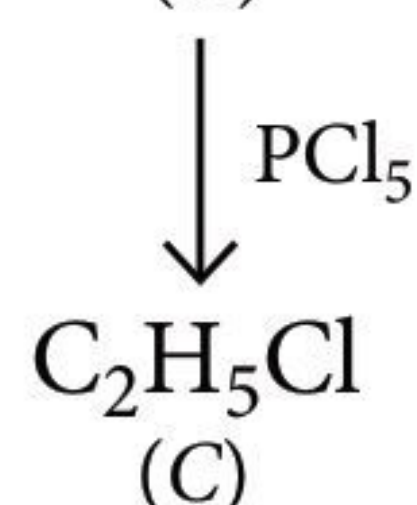
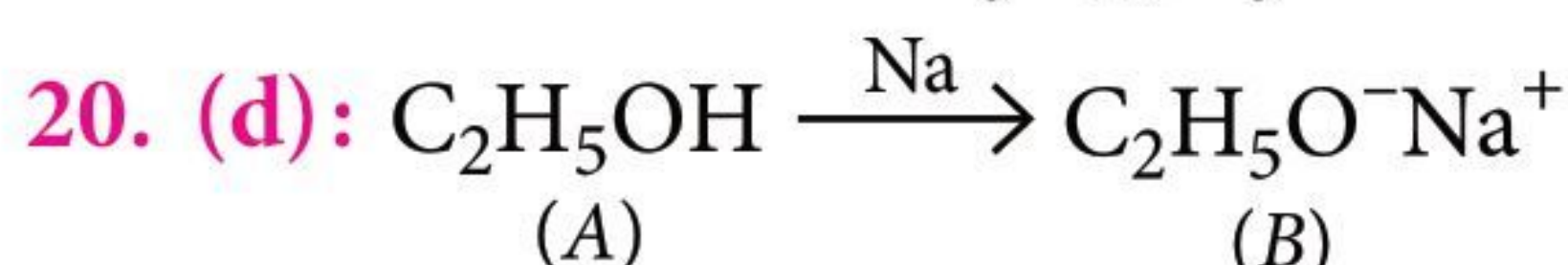
\therefore 0.833 moles of carbohydrate has hydrogen = 10 g

1 mole of carbohydrate has hydrogen = $\frac{10 \times 1}{0.833} = 12$ g

Given, empirical formula of carbohydrate = CH₂O

Since each H atom weighs 1 g, the number of hydrogen atom in the compound is 12.

Molecular formula = C₆H₁₂O₆



21. (d)

22. (a) : In aniline, lone pair of electrons on N-atom is delocalised over benzene ring and hence is less available for donation. Thus, aniline is less basic. Pyrrolidine, a 5-membered cyclic 2° amine is more basic (as lone pair is less hindered) than acyclic 2° amine (diethyl amine). Hence, the increasing order of basic strength is III < I < II.

23. (b) : Critical temperature is the temperature above which a gas cannot be liquified howsoever high pressure is applied.

24. (b) : $E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{0.0591}{n} \log \left[\frac{\text{Zn}^{2+}}{\text{Cu}^{2+}} \right]$

$E_1 = E_{\text{cell}}^\circ - \frac{0.0591}{2} \log \left(\frac{0.1}{1} \right) = E_{\text{cell}}^\circ + \frac{0.0591}{2}$

$E_2 = E_{\text{cell}}^\circ - \frac{0.0591}{2} \log \left(\frac{1}{1} \right) = E_{\text{cell}}^\circ - 0 = E_{\text{cell}}^\circ$

$E_3 = E_{\text{cell}}^\circ - \frac{0.0591}{2} \log \left(\frac{1}{0.1} \right) = E_{\text{cell}}^\circ - \frac{0.0591}{2}$

$\therefore E_1 > E_2 > E_3$



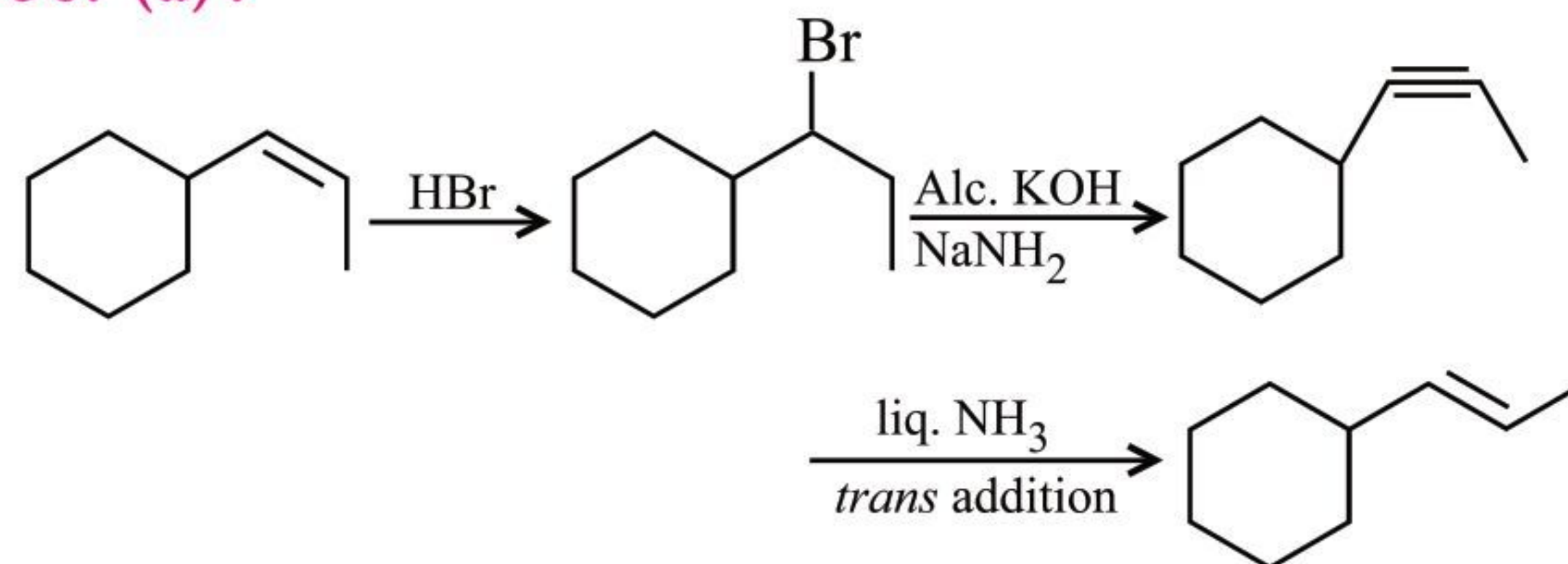
26. (d)

27. (c)

28. (a) : Ethyl benzene cannot be prepared by Wurtz reaction. In Wurtz reaction, only haloalkanes are converted into highest aliphatic saturated hydrocarbons.

29. (d) : *p*-Nitrophenol has intermolecular hydrogen bonding so it has more boiling point and is less volatile than *o*-nitrophenol which has intramolecular hydrogen bonding.

30. (a) :



31. (b) : Acidic strength $\propto -I$ effect

As oxygen is more electron withdrawing (II) and (III) shows greater $-I$ effect than (I). Thus, (I) is least acidic. Out of (II) and (III), (II) is more acidic than (III) as distance of O increases from $-\text{COOH}$ group, acidic strength decreases.

32. (c) : In solid state, for PCl₅:



33. (b) : $\Delta G^\circ = -nFE^\circ$; $-240000 = -2 \times 96,500 \times E^\circ$

$E^\circ = 1.24$ V

34. (b) : At 10°C rise, rate increases by 2.

$\frac{r_{100^\circ\text{C}}}{r_{10^\circ\text{C}}} = 2^{\left(\frac{100-10}{10}\right)} = 2^9 = 512$ times

35. (d) : Conjugate base (nucleophile) is strong if acid is weak and *vice-versa*.

- (A) $\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}^-$ is a conjugate base of $\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{OH}$ (I).
- (B) CH_3O^- is a conjugate base of CH_3OH (II).
- (C) CN^- is a conjugate base of HCN (III).

(D) $\text{H}_3\text{C}-\text{C}_6\text{H}_4-\text{SO}_3^-$ is a conjugate

base of $\text{H}_3\text{C}-\text{C}_6\text{H}_4-\text{SO}_3\text{H}$ (IV).

Order of acidic nature is $\text{IV} > \text{I} > \text{III} > \text{II}$.

Hence, the decreasing order of nucleophilicity is

$\text{B} > \text{C} > \text{A} > \text{D}$.

36. (c): More is the electronegativity of central atom (of non-metal), more is acidic nature of its oxoacid.

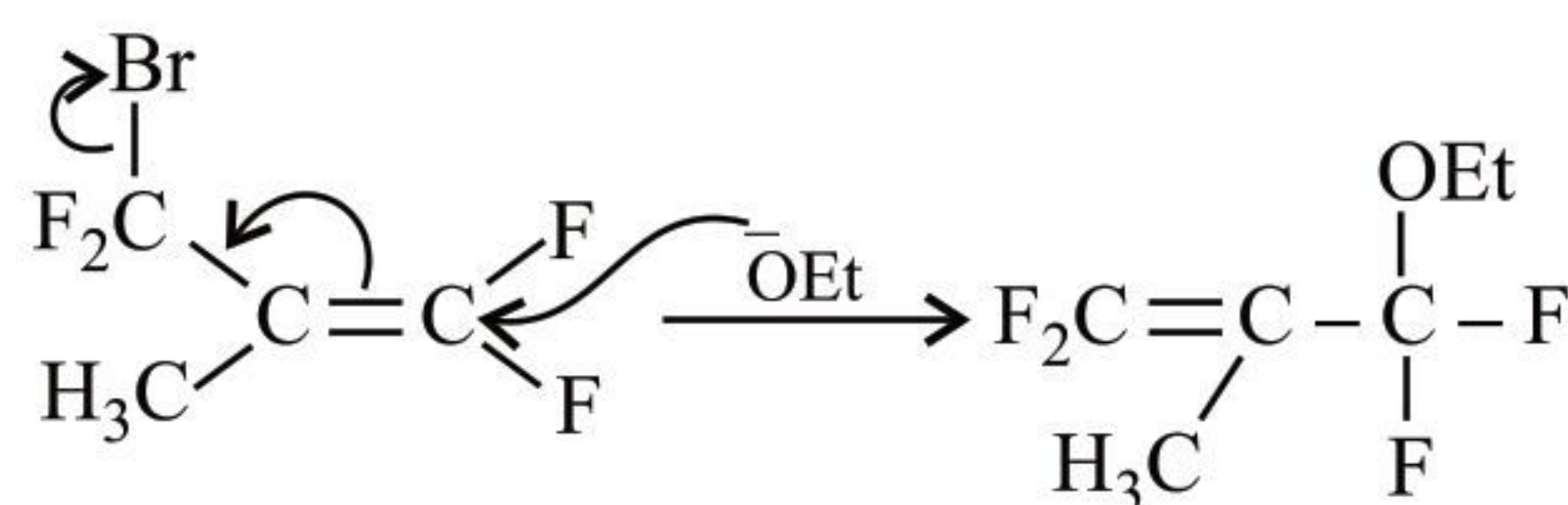
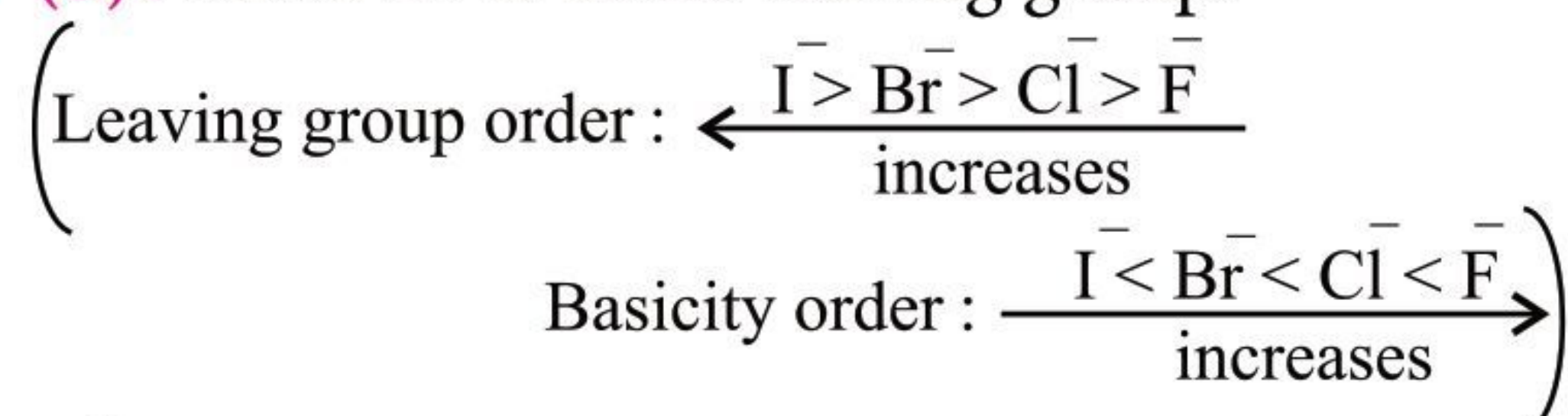
37. (a): Root mean square velocity, $c = \sqrt{\frac{3RT}{M}}$

From the above equation, lower the molecular mass, higher the *rms* velocity.

38. (c)

39. (b)

40. (b): Since Br^- is better leaving group.

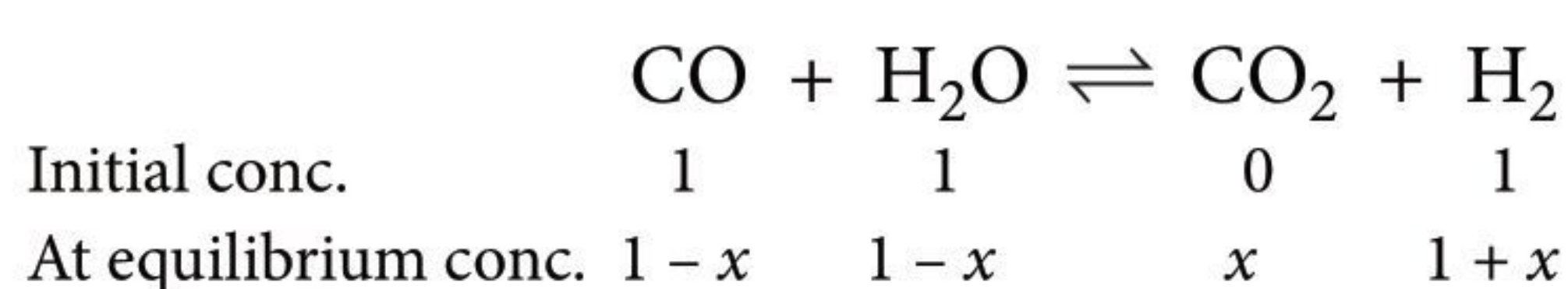


41. (c): In CO molecule, carbon and oxygen are linked by both σ and π bonds.

42. (b): Ge^{4+} is more stable than Ge^{2+} , thus GeCl_4 is more stable than GeCl_2 .

43. (b): Moles of water gas ($\text{CO} + \text{H}_2$) = $\frac{60}{30} = 2$

Moles of CO = Moles of H_2 = 1; Moles of steam = $\frac{18}{18} = 1$



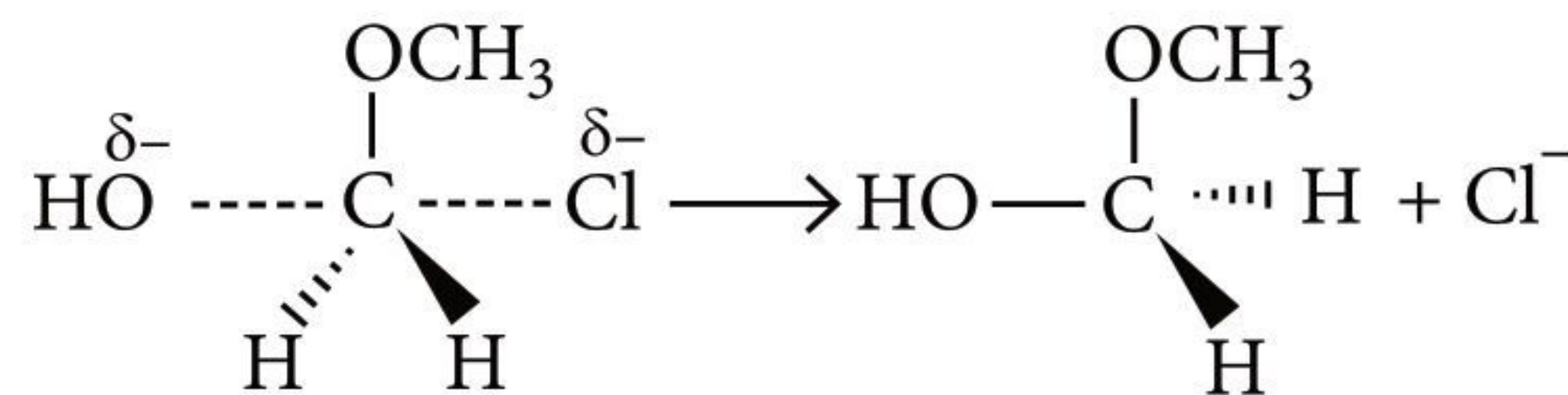
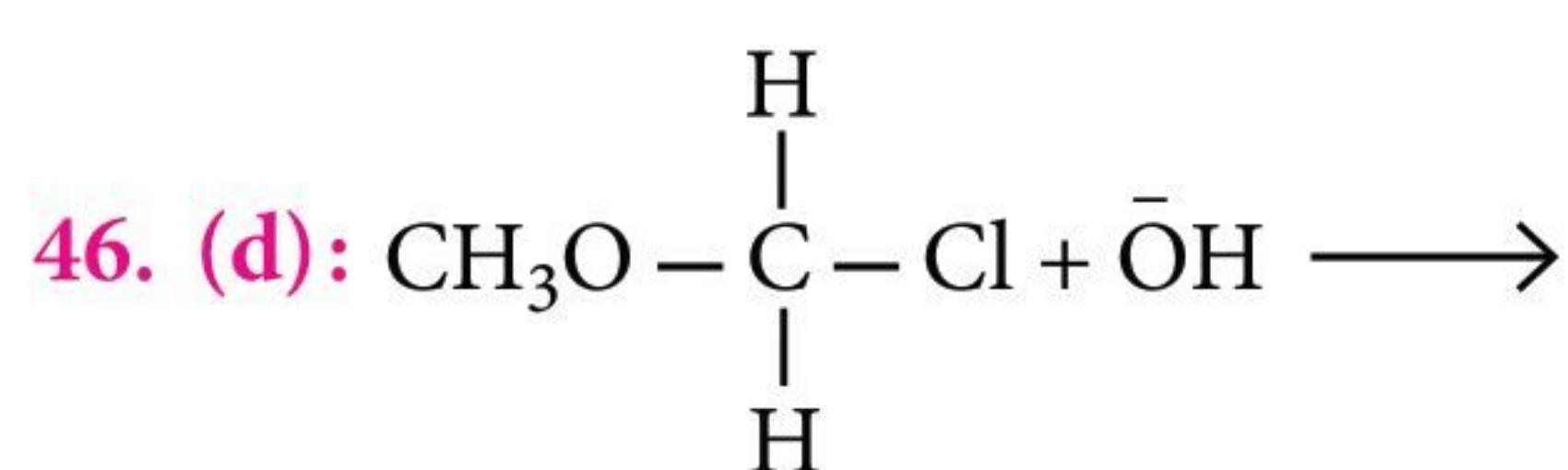
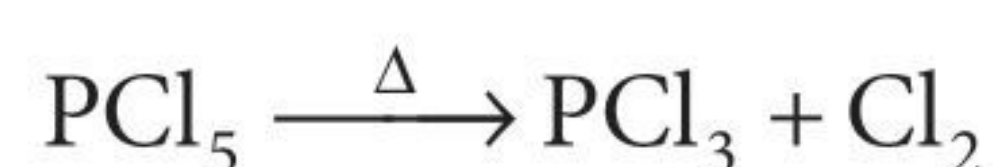
$$K = 3 = \frac{[\text{CO}_2][\text{H}_2]}{[\text{CO}][\text{H}_2\text{O}]} = \frac{x \times (1+x)}{(1-x)(1-x)}$$

$x = 0.5$; mol of $\text{CO}_2 = 0.5$

Hence, the mass of $\text{CO}_2 = 22 \text{ g}$

44. (d): The extent of hydration increases as group tendency to form H-bond increases. In general hydration of an aldehyde is greater than that of a ketone.

45. (b): PCl_5 is reactive because in its geometry two bonds are relatively longer and weaker and because of these two bonds P readily undergoes reaction.



Substitution nucleophilic bimolecular ($\text{S}_{\text{N}}2$)

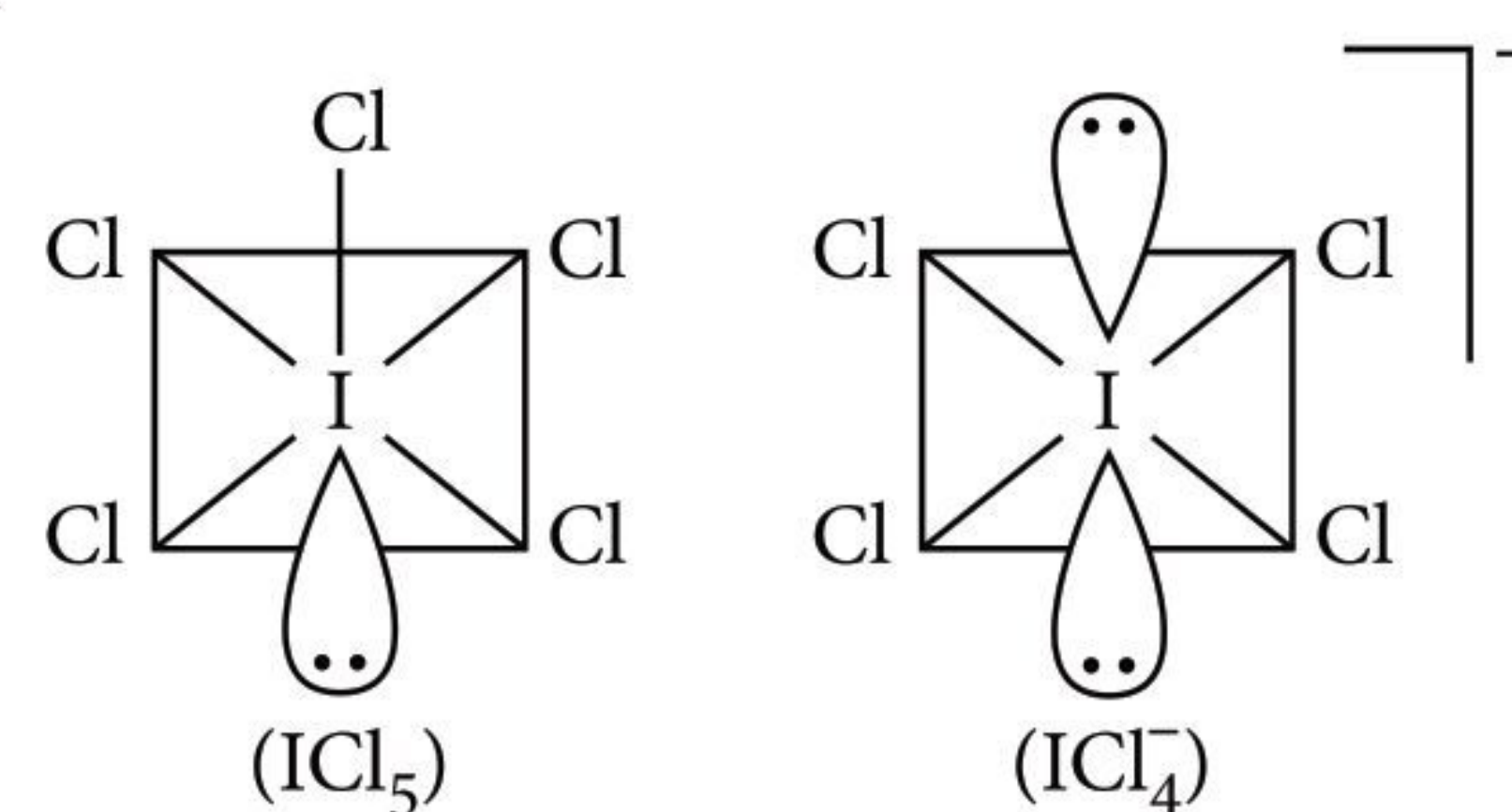
Also, $\text{CH}_3-\ddot{\text{O}}^+-\text{CH}_2 \longrightarrow$ Stabilised by resonance ($\text{S}_{\text{N}}1$)

47. (b): Boiling point decreases with increase in branching. Alcohols have higher boiling points than corresponding ketones because of hydrogen bonding in alcohols. Hence, the order is:

Isopentane < *n*-pentane < butanone < 1-butanol.

48. (b)

49. (b): Shape of ICl_5 is square pyramidal and ICl_4^- is square planar.



50. (d)



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CUET (UG)

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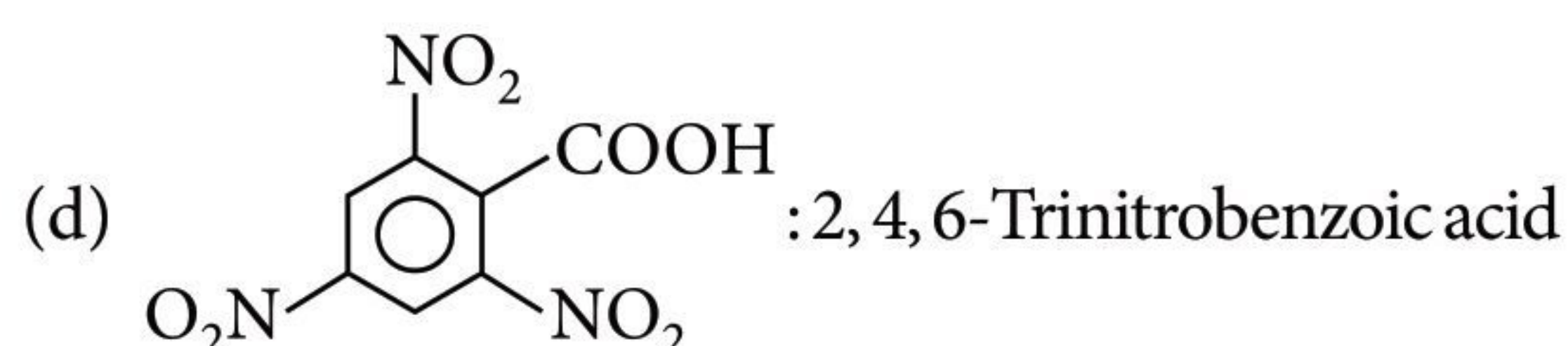
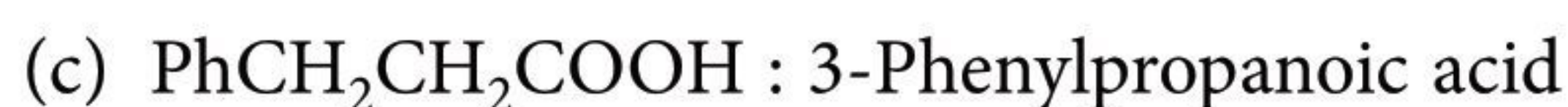
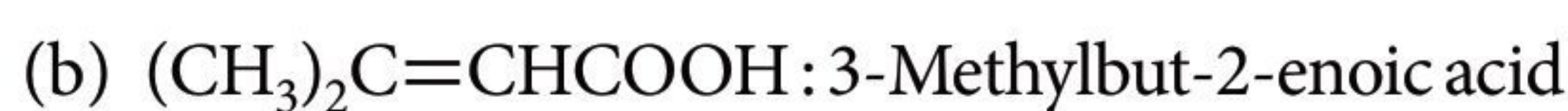
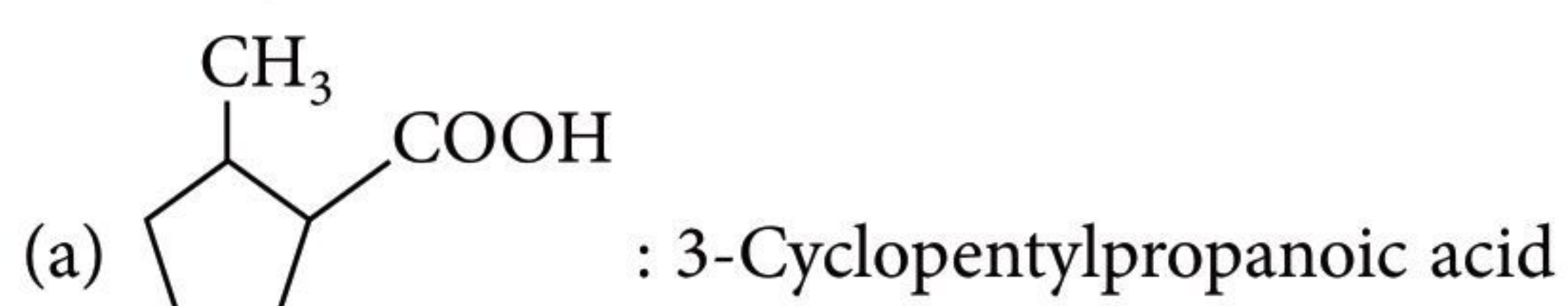
Section II of CUET (UG) is Domain specific. In this section of Chemistry 40 questions to be attempted out of 50.

Max. Marks : 200 Marks

Time : 45 minutes

Multiple Choice Questions (MCQs)

1. Which of the following IUPAC names is not correctly matched?



2. Which of the following statements is correct?

- (a) A saturated solution will remain saturated at all temperatures.
- (b) A plant cell swells when placed in hypertonic solution.
- (c) The depression in freezing point is directly proportional to molality of the solution.
- (d) Lowering in vapour pressure is a colligative property.

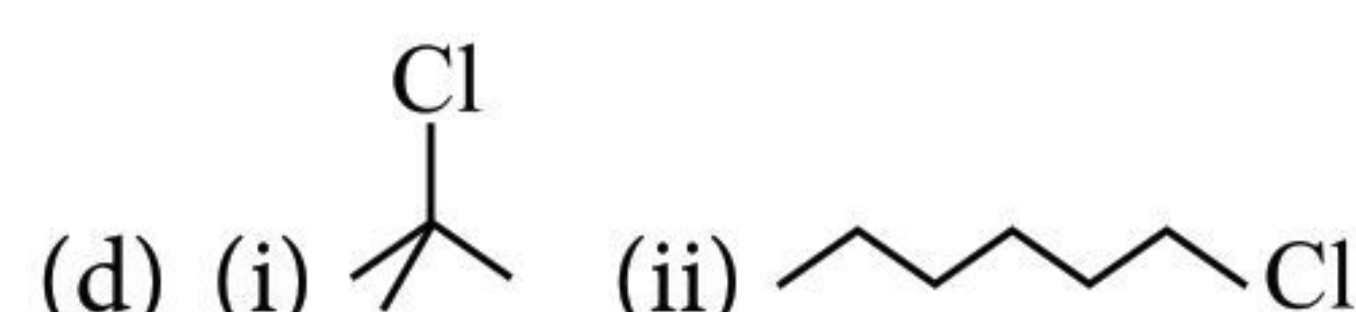
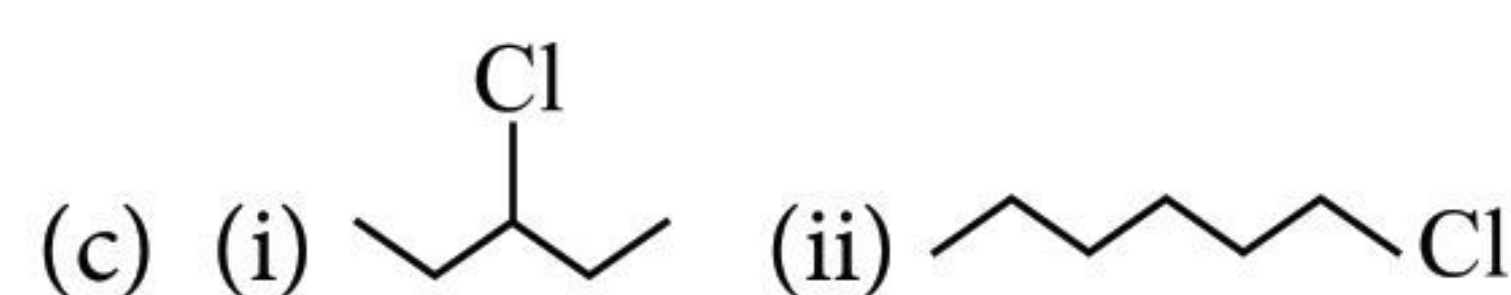
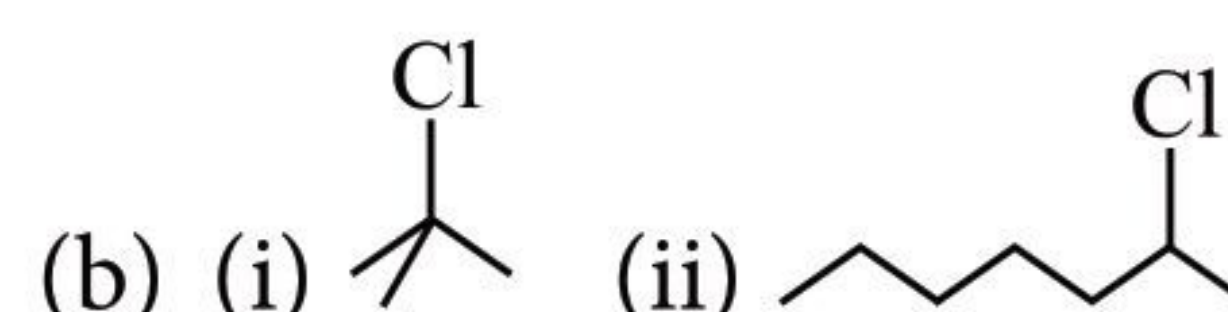
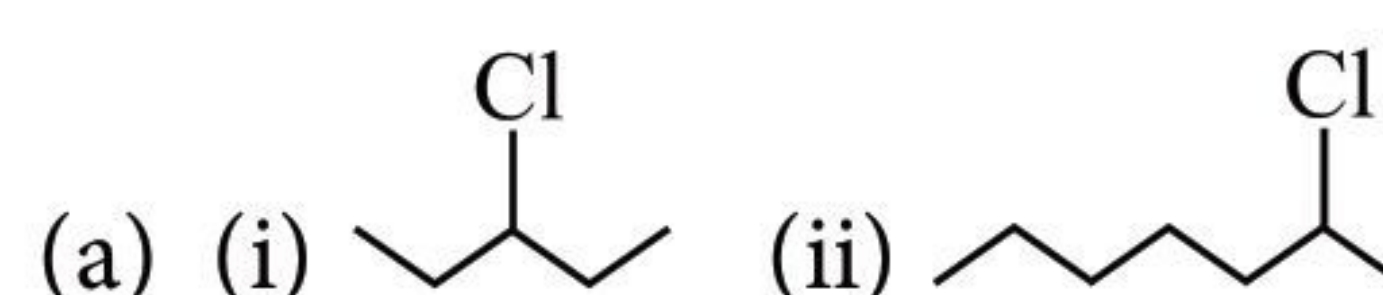
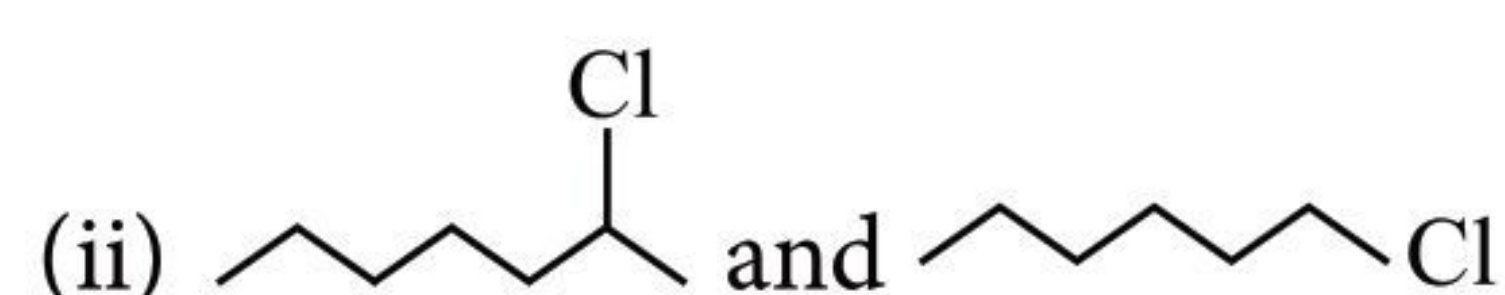
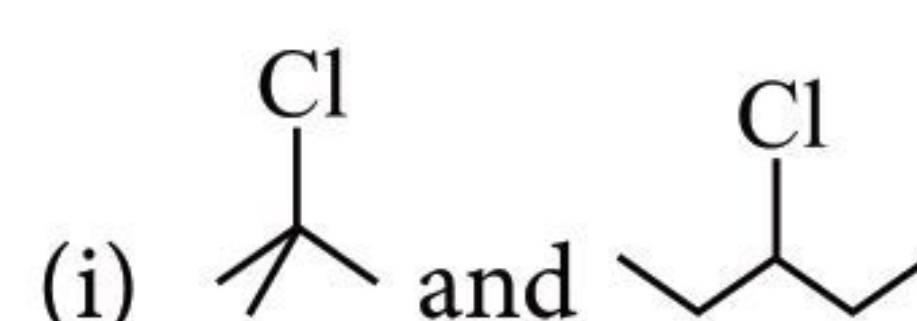
3. Lyophilic sols are more stable than lyophobic sols because,

- (a) the colloidal particles have no charge
- (b) the colloidal particles have positive charge
- (c) the colloidal particles are solvated
- (d) there is a strong electrostatic repulsion between the negatively charged colloidal particles.

4. The first noble gas compound was

- (a) XeO_3
- (b) XeF_4
- (c) XeF_6
- (d) $\text{Xe}^+[\text{PtF}_6]^-$

5. In the following pairs of halogen compounds, which compound undergoes faster $\text{S}_{\text{N}}1$ reaction?



6. Which polymer is used in the manufacture of paints and lacquers?

- (a) Polypropylene
- (b) Polyvinyl chloride
- (c) Bakelite
- (d) Glyptal

7. Choose the incorrect statement regarding detergent.
- (a) Detergents can be used both in soft and hard water.
 - (b) It is not easily biodegradable.
 - (c) It is sodium salt of fatty acids.
 - (d) It is superior to soaps.

8. The correct order of number of unpaired electrons is

- (a) $\text{Cu}^{2+} > \text{Ni}^{2+} > \text{Cr}^{3+} > \text{Fe}^{3+}$
- (b) $\text{Ni}^{2+} > \text{Cu}^{2+} > \text{Fe}^{3+} > \text{Cr}^{3+}$
- (c) $\text{Fe}^{3+} > \text{Cr}^{3+} > \text{Ni}^{2+} > \text{Cu}^{2+}$
- (d) $\text{Cr}^{3+} > \text{Fe}^{3+} > \text{Ni}^{2+} > \text{Cu}^{2+}$

9. A crystal is formed by two elements X and Y in cubic structure. X atoms are at the corners of a cube while Y atoms are at the face centre. The formula of the compound will be

- (a) XY
- (b) XY_2
- (c) X_2Y_3
- (d) XY_3

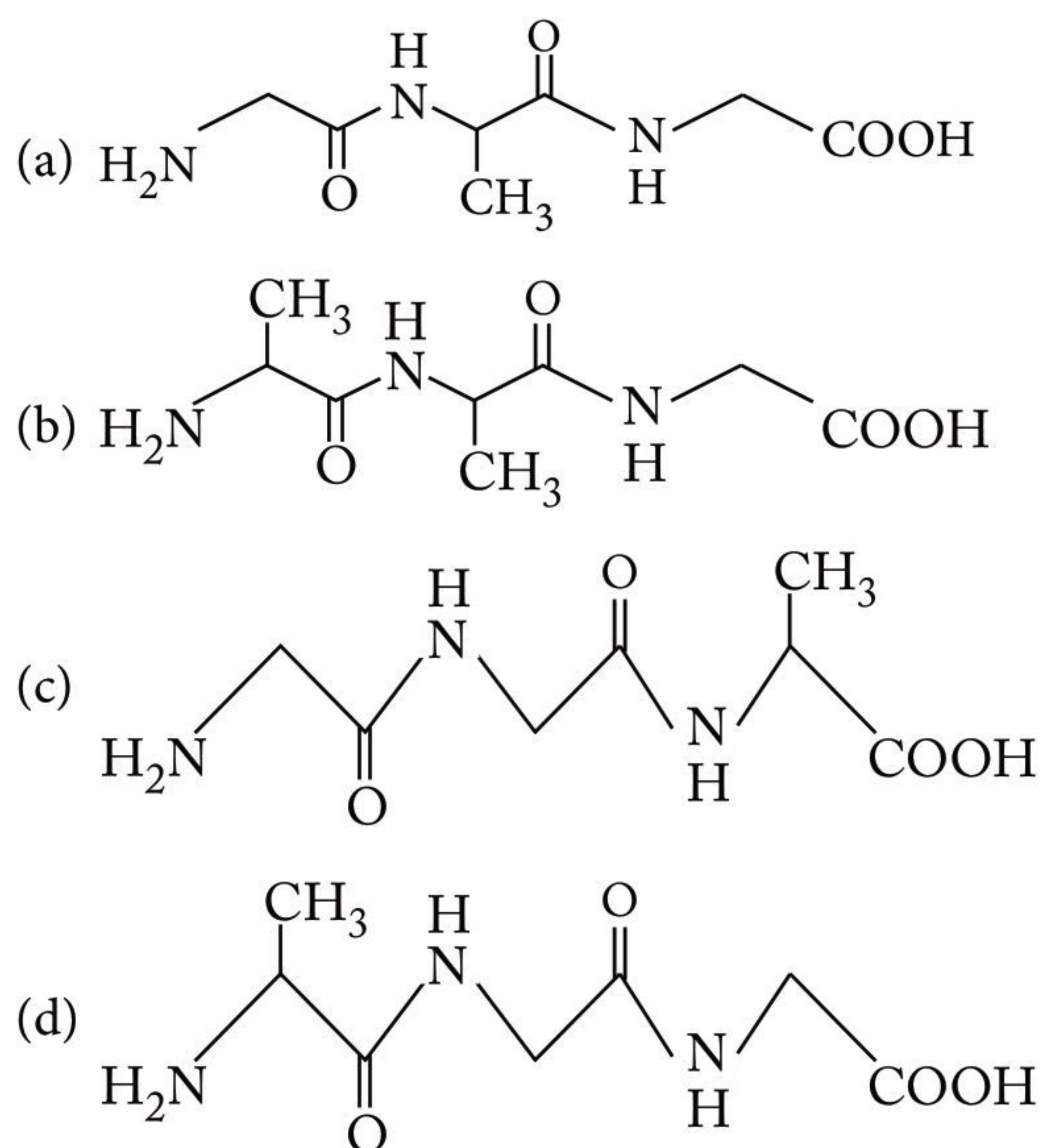
10. The correct statement on the isomerism associated with the following complex ions,

- (1) $[\text{Ni}(\text{H}_2\text{O})_5(\text{NH}_3)]^{2+}$
 (2) $[\text{Ni}(\text{H}_2\text{O})_4(\text{NH}_3)_2]^{2+}$ and
 (3) $[\text{Ni}(\text{H}_2\text{O})_3(\text{NH}_3)_3]^{2+}$ is
 (a) (1) and (2) show only geometrical isomerism
 (b) (1) and (2) show both geometrical and optical isomerism
 (c) (2) and (3) show both geometrical and optical isomerism
 (d) (2) and (3) show only geometrical isomerism.

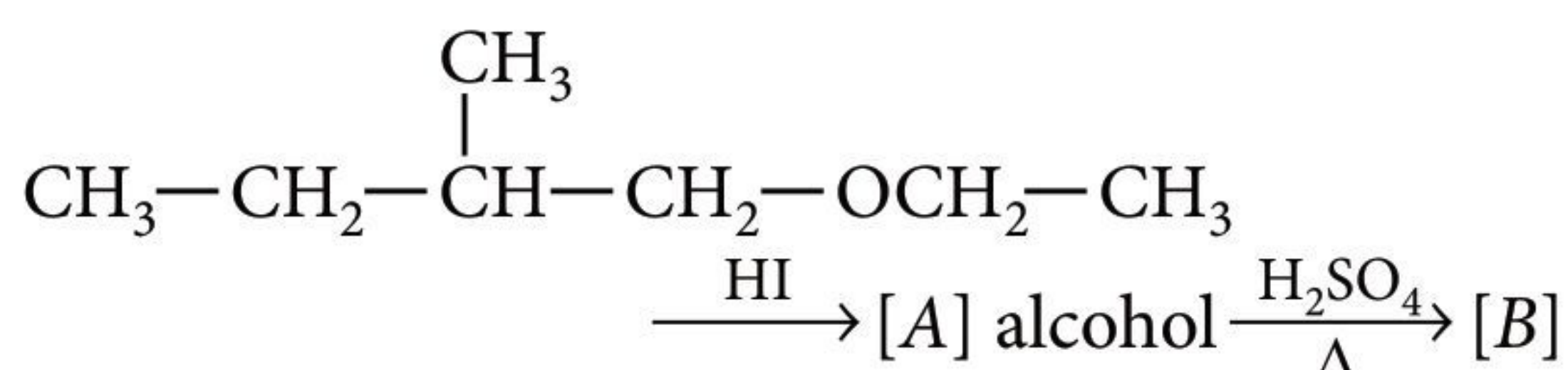
11. Which one of the following metals is obtained by leaching its ore with dilute cyanide solution?

- (a) Titanium (b) Vanadium
 (c) Silver (d) Zinc

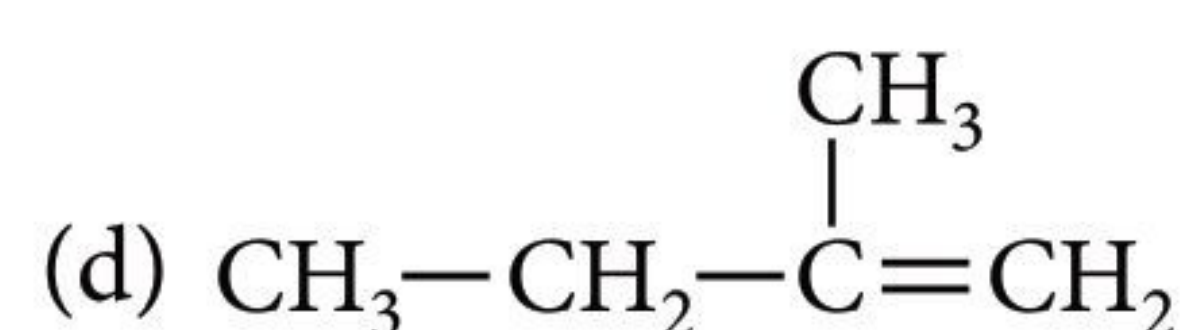
12. A tripeptide is written as glycine-alanine-glycine. The correct structure of tripeptide is



13. The major product [B] in the following sequence of reactions is



- (a) $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_3$
 (b) $\text{CH}_2=\text{CH}_2$
 (c) $\text{CH}_3-\text{CH}=\overset{\text{CH}_3}{\underset{|}{\text{C}}}-\text{CH}_3$



14. The half-cell reactions with their appropriate standard reduction potentials are

- (i) $\text{Pb}^{2+} + 2e^- \rightarrow \text{Pb}$ ($E^\circ = -0.13 \text{ V}$)
 (ii) $\text{Ag}^+ + e^- \rightarrow \text{Ag}$ ($E^\circ = +0.80 \text{ V}$)

Based on the above data, which of the following reactions will take place?

- (a) $\text{Pb}^{2+} + 2\text{Ag} \rightarrow 2\text{Ag}^+ + \text{Pb}$
 (b) $2\text{Ag} + \text{Pb} \rightarrow 2\text{Ag}^+ + \text{Pb}^{2+}$
 (c) $2\text{Ag}^+ + \text{Pb} \rightarrow \text{Pb}^{2+} + 2\text{Ag}$
 (d) $\text{Pb}^{2+} + 2\text{Ag}^+ \rightarrow \text{Pb} + \text{Ag}$

15. A first order reaction is 75% complete after 32 minutes. When was 50% of the reaction completed?

- (a) 16 min (b) 8 min (c) 4 min (d) 32 min

16. Which of the following is the correct increasing order of basicity of amines in gaseous phase?

- (a) $(\text{CH}_3)_2\text{NH} > \text{CH}_3\text{NH}_2 > (\text{CH}_3)_3\text{N} > \text{NH}_3$
 (b) $(\text{CH}_3)_3\text{N} > (\text{CH}_3)_2\text{NH} > \text{CH}_3\text{NH}_2 > \text{NH}_3$
 (c) $(\text{CH}_3)_2\text{NH} > (\text{CH}_3)_3\text{N} > \text{CH}_3\text{NH}_2 > \text{NH}_3$
 (d) $(\text{CH}_3)_3\text{N} > \text{CH}_3\text{NH}_2 > (\text{CH}_3)_2\text{NH} > \text{NH}_3$

17. The parameters of the unit cell of a substance are $a = 2.5$, $b = 3.0$, $c = 4.0$, $\alpha = 90^\circ$, $\beta = 120^\circ$, $\gamma = 90^\circ$. The crystal system of the substance is

- (a) orthorhombic (b) triclinic
 (c) hexagonal (d) monoclinic.

18. The mole fraction of a solvent in aqueous solution of a solute is 0.8. The molality (in mol kg^{-1}) of the aqueous solution is

- (a) 13.88×10^{-3} (b) 13.88×10^{-1}
 (c) 13.88×10^{-2} (d) 13.88

19. Given $\Lambda^\circ \left(\frac{1}{3} \text{Al}^{3+} \right) = 63 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$ and $\Lambda^\circ \left(\frac{1}{2} \text{SO}_4^{2-} \right) = 80 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$.

The value of $\Lambda^\circ [\text{Al}_2(\text{SO}_4)_3]$ would be :

- (a) $143 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$ (b) $206 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$
 (c) $286 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$ (d) $858 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$

20. For the reaction $2\text{A} + \text{B} \rightarrow \text{C}$, the values of initial rate at different reactant concentrations are given in the table below. The rate law for the reaction is

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[A] (mol L ⁻¹)	[B] (mol L ⁻¹)	Initial Rate (mol L ⁻¹ s ⁻¹)
0.05	0.05	0.045
0.10	0.05	0.090
0.20	0.10	0.72

- (a) rate = $k[A]^2[B]^2$ (b) rate = $k[A][B]$
(c) rate = $k[A][B]^2$ (d) rate = $k[A]^2[B]$

21. Which of the following statements does not show correct difference between adsorption and absorption?

- (a) In adsorption the substance is concentrated only at the surface while in absorption it is uniformly distributed in the bulk.
(b) Adsorption is instantaneous while absorption is a slow process.
(c) A substance can be adsorbed as well as absorbed simultaneously and the process is called sorption.
(d) Only gases are adsorbed while solids and liquids are absorbed.

22. The correct statement is

- (a) zone refining process is used for the refining of titanium
(b) zincite is a carbonate ore
(c) aniline is a froth stabilizer
(d) sodium cyanide cannot be used in the metallurgy of silver.

23. Complete the given equations

- (i) $\text{Mg} + 2\text{HNO}_3 \rightarrow \text{Mg}(\text{NO}_3)_2 + \dots\dots W$
(ii) $\text{Cu} + 8\text{HNO}_3 \rightarrow 3\text{Cu}(\text{NO}_3)_2 + \dots\dots X + 4\text{H}_2\text{O}$
(iii) $8\text{NH}_3 + 3\text{Cl}_2 \xrightarrow{\text{(excess)}} \dots\dots Y + \text{N}_2$
(iv) $\text{I}_2 + 10\text{HNO}_3 \rightarrow \dots\dots Z + 10\text{NO}_2 + 4\text{H}_2\text{O}$

W	X	Y	Z
(a) NO	2NO ₂	6NCl ₃	5HIO ₃
(b) H ₂	2NO	6NH ₄ Cl	2HIO ₃
(c) H ₂	N ₂	NCl ₃	HI
(d) NO ₂	N ₂ O	2NH ₄ Cl	3HI

24. The decrease of ionic radii in lanthanide elements in a row is due to

- (a) efficient shielding by *f*-orbitals for the attraction of ns^2 -electrons by the nucleus
(b) only the attraction of ns^2 -electrons by the nucleus

- (c) inefficient shielding by *f*-orbitals for the attraction of ns^2 -electrons by the nucleus
(d) different shapes of *f*-orbitals.

25. The type of hybridisation and magnetic property of the complex $[\text{MnCl}_6]^{3-}$, respectively are

- (a) sp^3d^2 and diamagnetic
(b) d^2sp^3 and paramagnetic
(c) sp^3d^2 and paramagnetic
(d) d^2sp^3 and diamagnetic.

26. When *neo*-pentyl bromide is subjected to Wurtz reaction, the product formed is

- (a) 2, 2, 4, 4-tetramethylhexane
(b) 2, 2, 4, 4-tetramethylpentane
(c) 2, 2, 5, 5-tetramethylhexane
(d) 2, 2, 3, 3-tetramethylhexane.

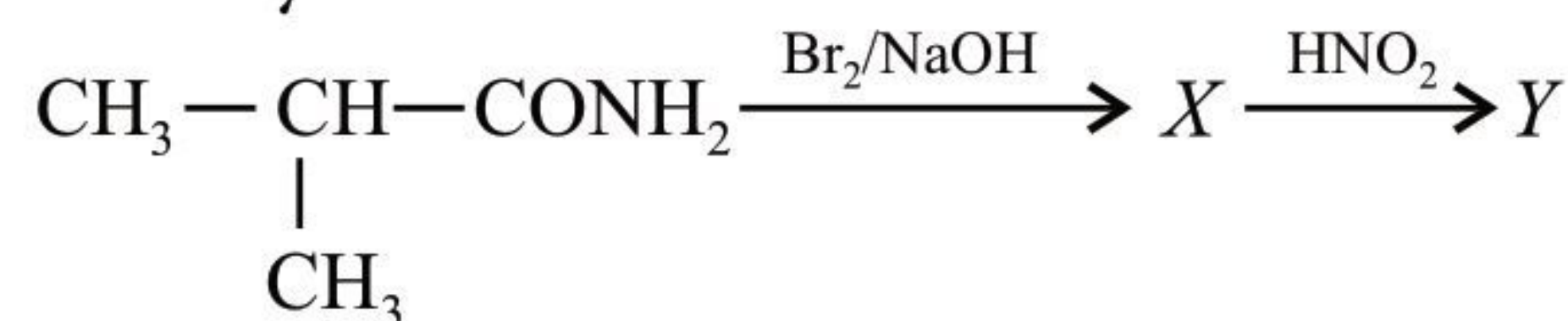
27. Which of the following alcohols reacts most readily with Lucas reagent?

- (a) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (b) $\text{CH}_3-\underset{\text{OH}}{\text{CH}}-\text{CH}_3$
(c) $\text{CH}_3-\underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}}-\text{OH}$ (d) $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2\text{OH}$

28. The increasing order of the reactivity of the following compounds in nucleophilic addition reaction is

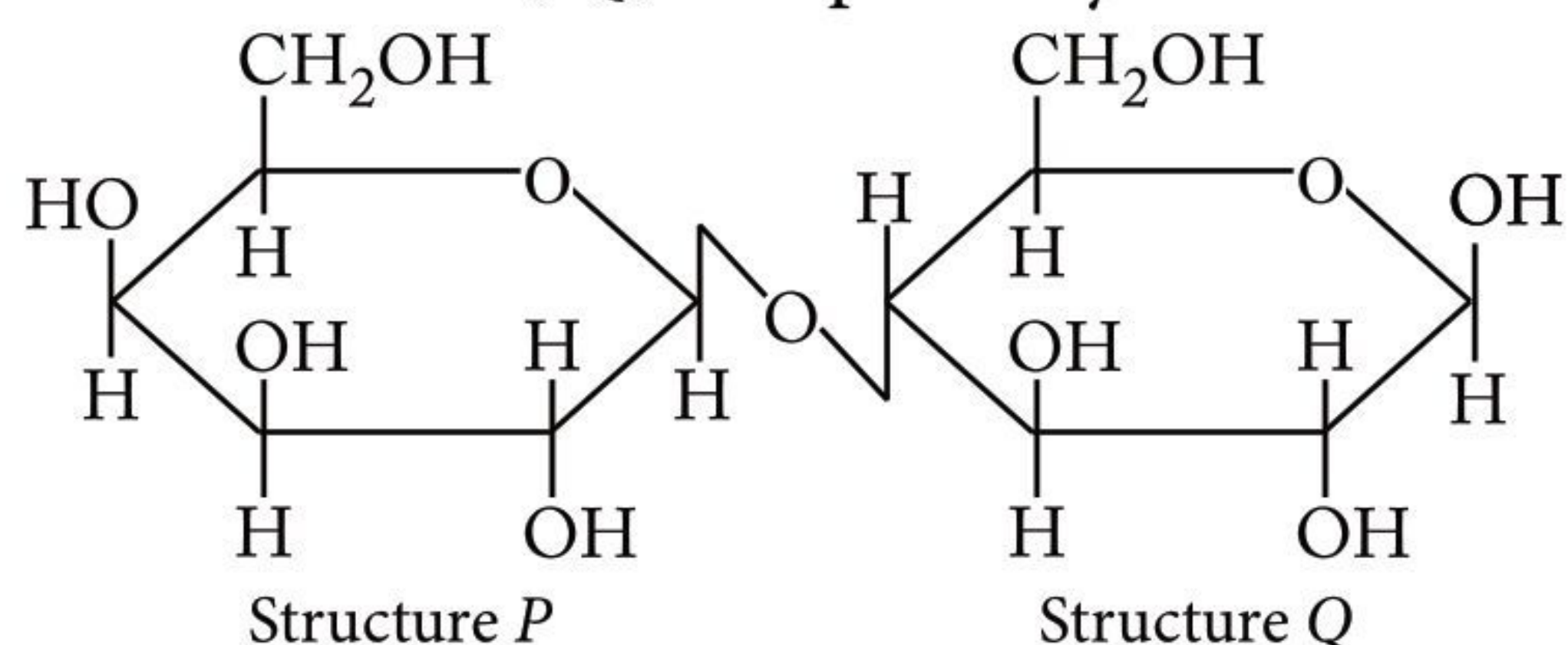
- Propanal, Benzaldehyde, Propanone, Butanone
(a) benzaldehyde < butanone < propanone < propanal
(b) butanone < propanone < benzaldehyde < propanal
(c) propanal < propanone < butanone < benzaldehyde
(d) benzaldehyde < propanal < propanone < butanone.

29. Identify X and Y in the reaction.



- (a) $X = \text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2\text{NH}_2$; $Y = \text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2\text{OH}$
(b) $X = \text{CH}_3\text{CH}=\text{CHNH}_2$; $Y = \text{CH}_3\text{CH}=\text{CHOH}$
(c) $X = \text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{NH}_2$; $Y = \text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{OH}$
(d) $X = \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$; $Y = \text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

30. Structure *R* is formed by joining structures *P* and *Q*. The names of *P*, *Q*, *R* respectively are



- (a) *P* = α -D-glucose, *Q* = β -D-galactose, *R* = Sucrose
 (b) *P* = β -D-galactose, *Q* = β -D-glucose, *R* = Lactose
 (c) *P* = α -D-glucose, *Q* = α -D-galactose, *R* = Maltose
 (d) *P* = β -D-galactose, *Q* = β -D-glucose, *R* = Amylose
31. Preparation of bakelite proceeds via reactions
 (a) electrophilic addition and dehydration
 (b) condensation and elimination
 (c) nucleophilic addition and dehydration
 (d) electrophilic substitution and dehydration.
32. Which of the following statement is correct?
 (a) Some tranquilizers function by inhibiting the enzymes which catalyse the degradation of noradrenaline.
 (b) Tranquilizers are non-narcotic drugs.
 (c) Tranquilizers are chemical compounds that do not affect the message transfer from nerve to receptor.
 (d) Tranquilizers are chemical compounds that can relieve pain and fever.
33. Which of the following is an example of homoleptic complex?
 (a) $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$ (b) $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$
 (c) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]$ (d) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$
34. Consider the acidity of the carboxylic acids:
 (i) PhCOOH (ii) $o\text{-NO}_2\text{C}_6\text{H}_4\text{COOH}$
 (iii) $p\text{-NO}_2\text{C}_6\text{H}_4\text{COOH}$ (iv) $m\text{-NO}_2\text{C}_6\text{H}_4\text{COOH}$
 Which of the following order is correct?
 (a) $i > ii > iii > iv$ (b) $ii > iv > iii > i$
 (c) $ii > iv > i > iii$ (d) $ii > iii > iv > i$

Assertion & Reason Based MCQs

For question numbers 35-38, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- (a) If both assertion and reason are correct and reason is the correct explanation of assertion.
 (b) If both assertion and reason are correct but reason is not the correct explanation of assertion.
 (c) If assertion is correct but reason is wrong.
 (d) If assertion is wrong but reason is correct.

35. **Assertion :** Kohlrausch law helps to find the molar conductivity of weak electrolytes at infinite dilution.

Reason : Molar conductivity of a weak electrolyte at infinite dilution cannot be determined experimentally.

36. **Assertion :** The maximum oxidation state of chromium in its compounds is +6.

Reason : Chromium has only six electrons in *ns* and $(n - 1)d$ orbitals.

37. **Assertion :** α -Amino acids are the building blocks of proteins.

Reason : Natural amino acids are mostly α -amino acids.

38. **Assertion :** Replacement of $-\text{Cl}$ group by $-\text{OH}$ in chlorobenzene is easier if nitro group is present in the ring.

Reason : Nitro group leads to strengthen the $\text{C}-\text{Cl}$ bond in chlorobenzene.

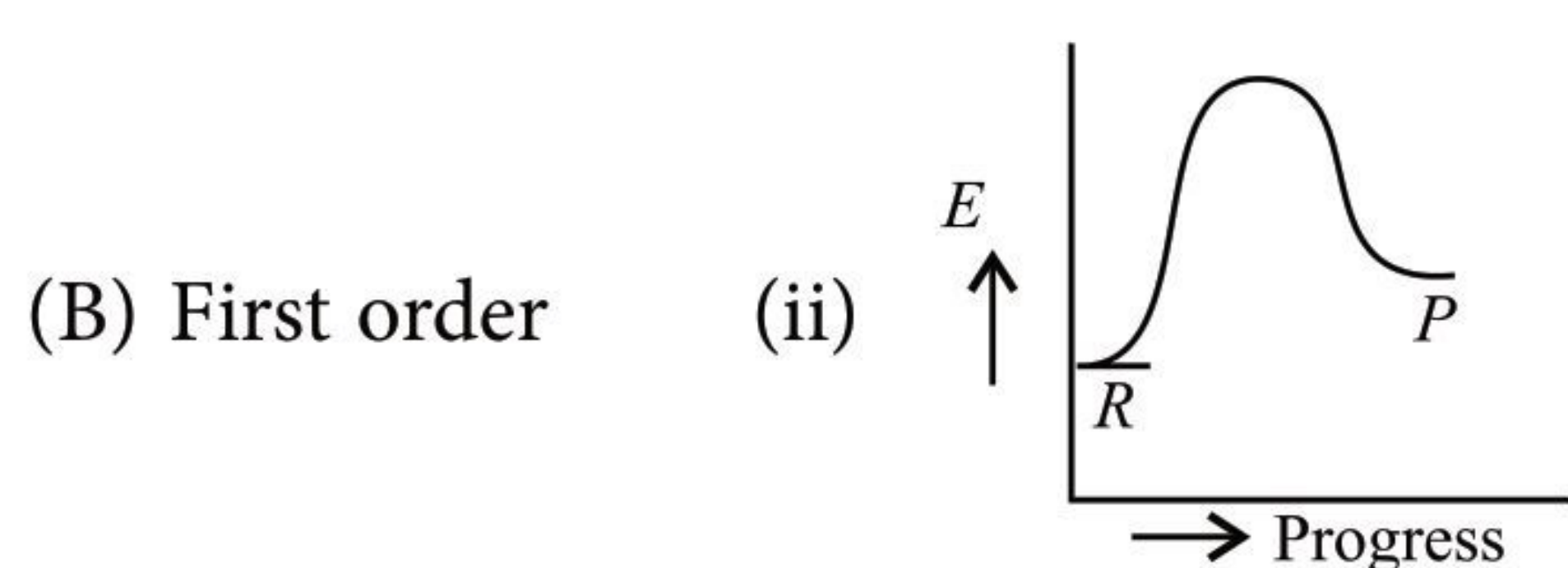
Match the Column

39. Match the reagents in column I with products formed by reactions with acetone in column II and mark the appropriate choice.

Column I	Column II
(A) Hydrazine	(i) $(\text{CH}_3)_2\text{C}=\text{NNHCONH}_2$
(B) Semicarbazide	(ii) $(\text{CH}_3)_2\text{C}=\text{NOH}$
(C) Phenylhydrazine	(iii) $(\text{CH}_3)_2\text{C}=\text{NNH}_2$
(D) Hydroxylamine	(iv) $(\text{CH}_3)_2\text{C}=\text{NNHC}_6\text{H}_5$
(a) $(A) \rightarrow (i), (B) \rightarrow (ii), (C) \rightarrow (iii), (D) \rightarrow (iv)$	
(b) $(A) \rightarrow (iv), (B) \rightarrow (iii), (C) \rightarrow (ii), (D) \rightarrow (i)$	
(c) $(A) \rightarrow (iii), (B) \rightarrow (i), (C) \rightarrow (iv), (D) \rightarrow (ii)$	
(d) $(A) \rightarrow (ii), (B) \rightarrow (iv), (C) \rightarrow (i), (D) \rightarrow (iii)$	

40. Match the column I with column II and mark the appropriate choice.

Column I	Column II
(A) Zero order	(i) $\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left[\frac{T_2 - T_1}{T_1 T_2} \right]$



(C) Endothermic reaction (iii) $k = \frac{2.303}{t} \log \frac{[A]_0}{[A]}$

(D) Activation energy (iv) $k = \frac{1}{t} ([A]_0 - [A])$

- (a) (A) → (iv), (B) → (iii), (C) → (ii), (D) → (i)
 (b) (A) → (i), (B) → (ii), (C) → (iii), (D) → (iv)
 (c) (A) → (ii), (B) → (iii), (C) → (iv), (D) → (i)
 (d) (A) → (iii), (B) → (iv), (C) → (i), (D) → (ii)

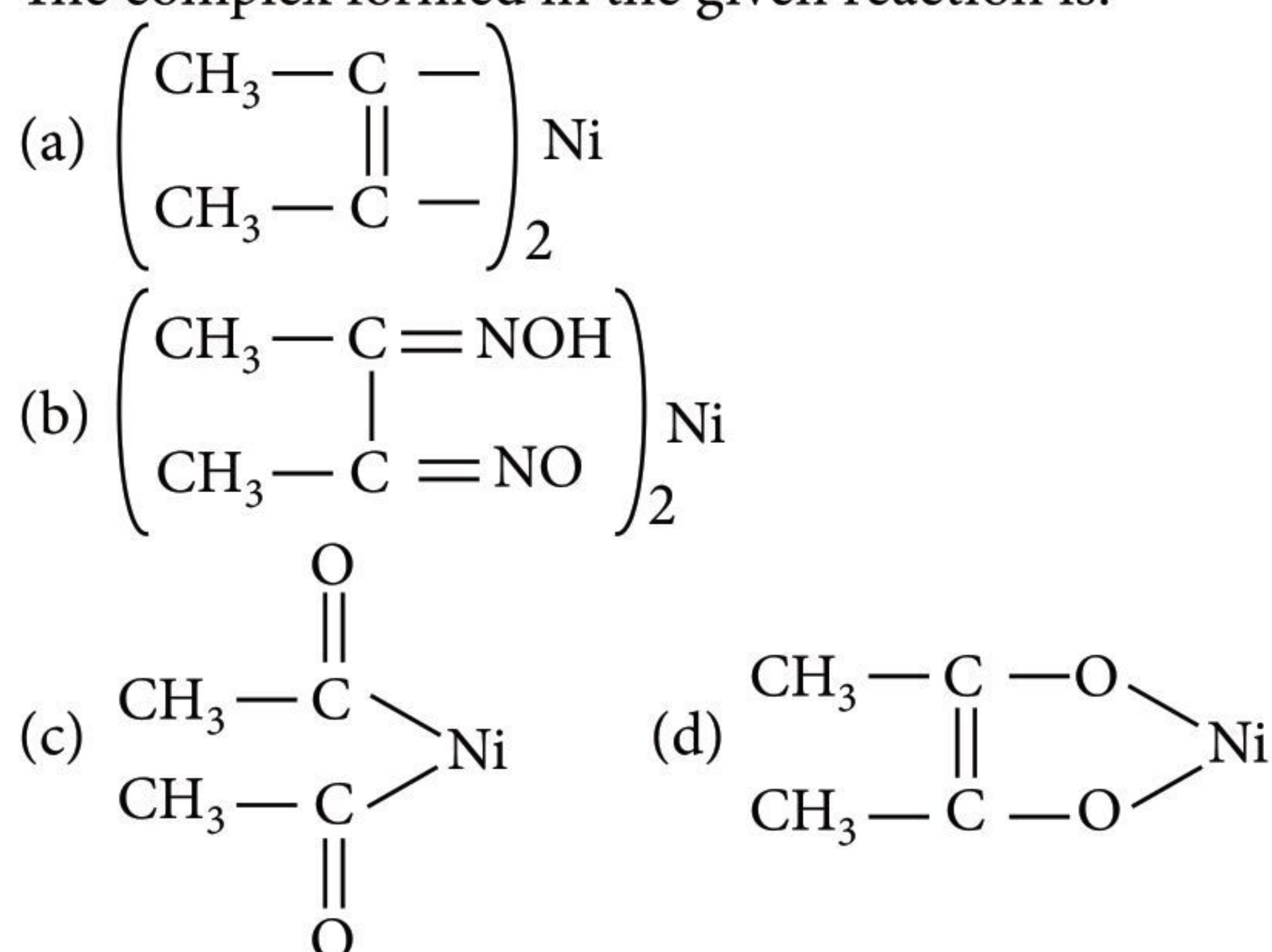
Case Based MCQs

Case I : Read the passage given below and answer the following questions from 41 to 45.

The molecular compounds which are formed from the combination of two or more simple stable compounds and retain their identity in the solid as well as in the dissolved state are called coordination compounds. Their properties are completely different from the constituents. In coordination compounds, the central metal atom or ion is linked to a number of ions or neutral molecules, called ligands, by coordinate bonds. For example, Dimethyl glyoxime (dmg) is a bidentate ligand chelating large amounts of metals.

When dimethyl glyoxime is added to alcoholic solution of NiCl_2 and ammonium hydroxide is slowly added to it, a rosy red precipitate of a complex is formed.

41. The complex formed in the given reaction is:



42. Oxidation number of Ni in the given complex is

- (a) +3 (b) +1 (c) +2 (d) zero.

43. Hybridisation of Ni and structure of the complex is
 (a) sp^3 , tetrahedral (b) dsp^2 , square planar
 (c) sp^3 , square planar
 (d) sp^3d , trigonal bipyramidal.

44. Which of the following is true about this complex?

- (a) It is paramagnetic, containing 2 unpaired electrons.
 (b) It is paramagnetic, containing 1 unpaired electron.
 (c) It is paramagnetic, containing 4 unpaired electrons.
 (d) It is diamagnetic with no unpaired electron.

45. Which one will give test for Fe^{3+} ions in the solution?

- (a) $[\text{Fe}(\text{CN})_6]^{3-}$
 (b) $[\text{Fe}(\text{CN})_6]^{2-}$
 (c) $(\text{NH}_4)_2\text{SO}_4 \cdot \text{FeSO}_4 \cdot 6\text{H}_2\text{O}$
 (d) $\text{Fe}_2(\text{SO}_4)_3$

Case II : Read the passage given below and answer the following questions from 46 to 50.

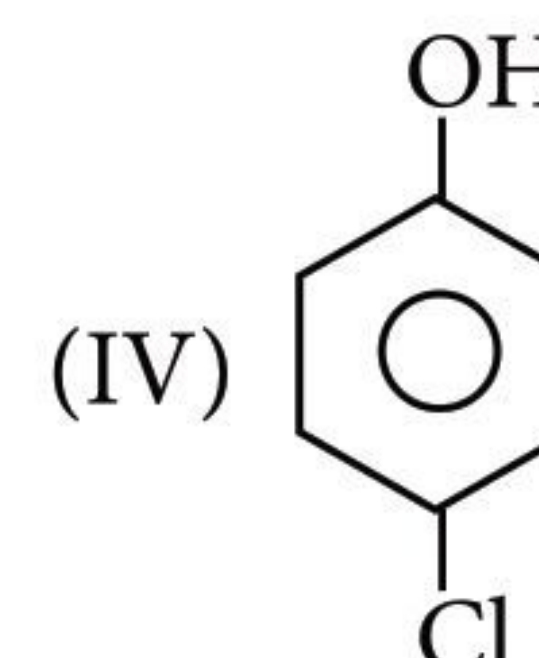
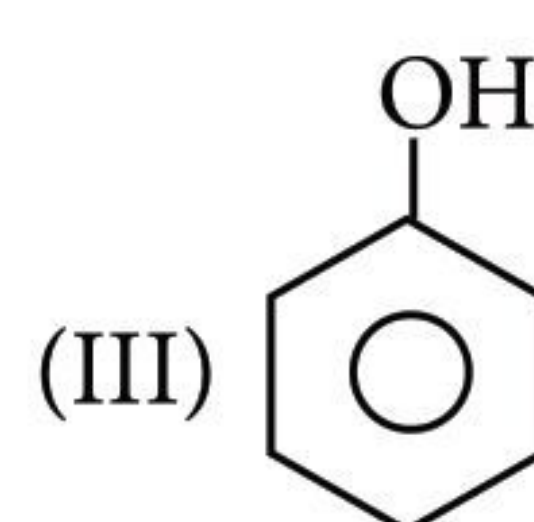
Both alcohols and phenols are acidic in nature, but phenols are more acidic than alcohols. Acidic strength of alcohols mainly depends upon the inductive effect. Acidic strength of phenols depends upon a combination of both inductive effect and resonance effects of the substituent and its position on the benzene ring. Electron withdrawing groups increases the acidic strength of phenols whereas electron donating groups decreases the acidic strength of phenols. Phenol is a weaker acid than carboxylic acid.

46. Phenols are highly acidic as compared to alcohols due to

- (a) the higher molecular mass of phenols
 (b) the stronger hydrogen bonds in phenols
 (c) alkoxide ion is a strong conjugate base
 (d) phenoxide ion is resonance stabilised.

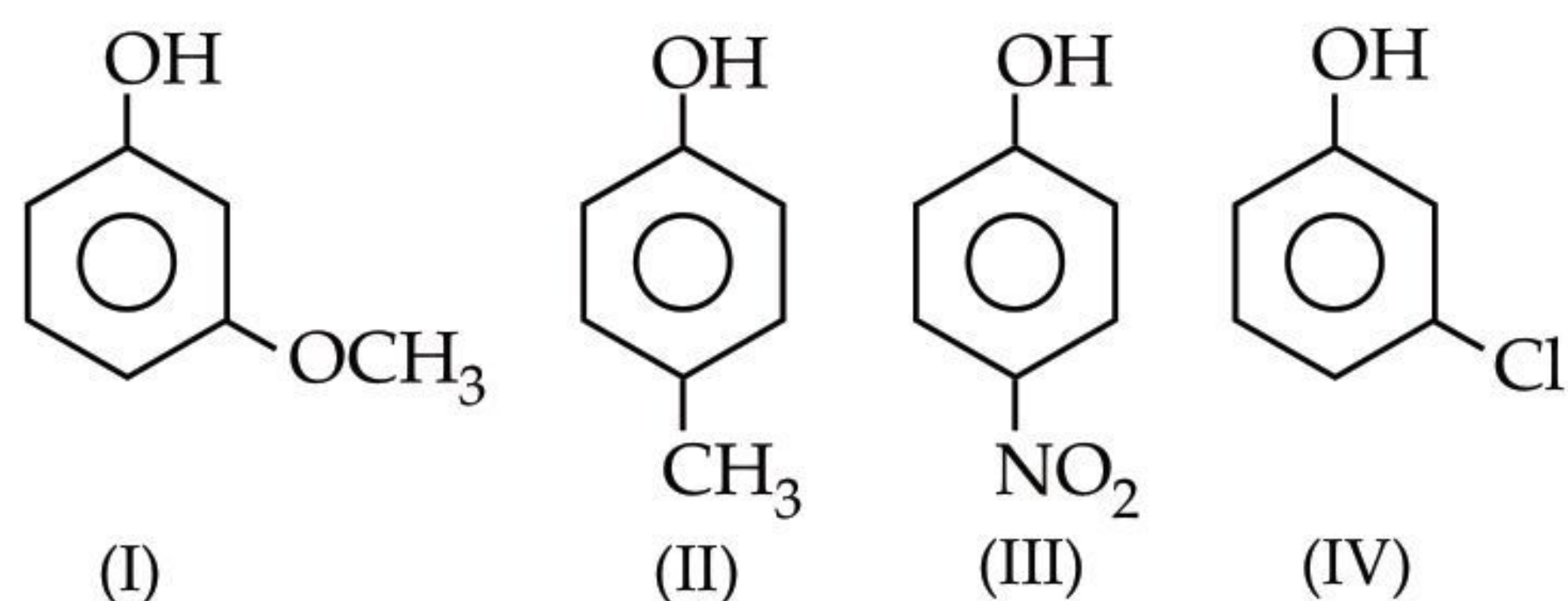
47. The correct order of acidic strength among the following is

- (I) H_2O (II) $\text{CH}_3\text{CH}_2\text{OH}$



- (a) (III) > (IV) > (II) > (I)
 (b) (IV) > (III) > (I) > (II)
 (c) (IV) > (III) > (II) > (I)
 (d) (I) > (II) > (IV) > (III)

48. The correct decreasing order of pK_a value is

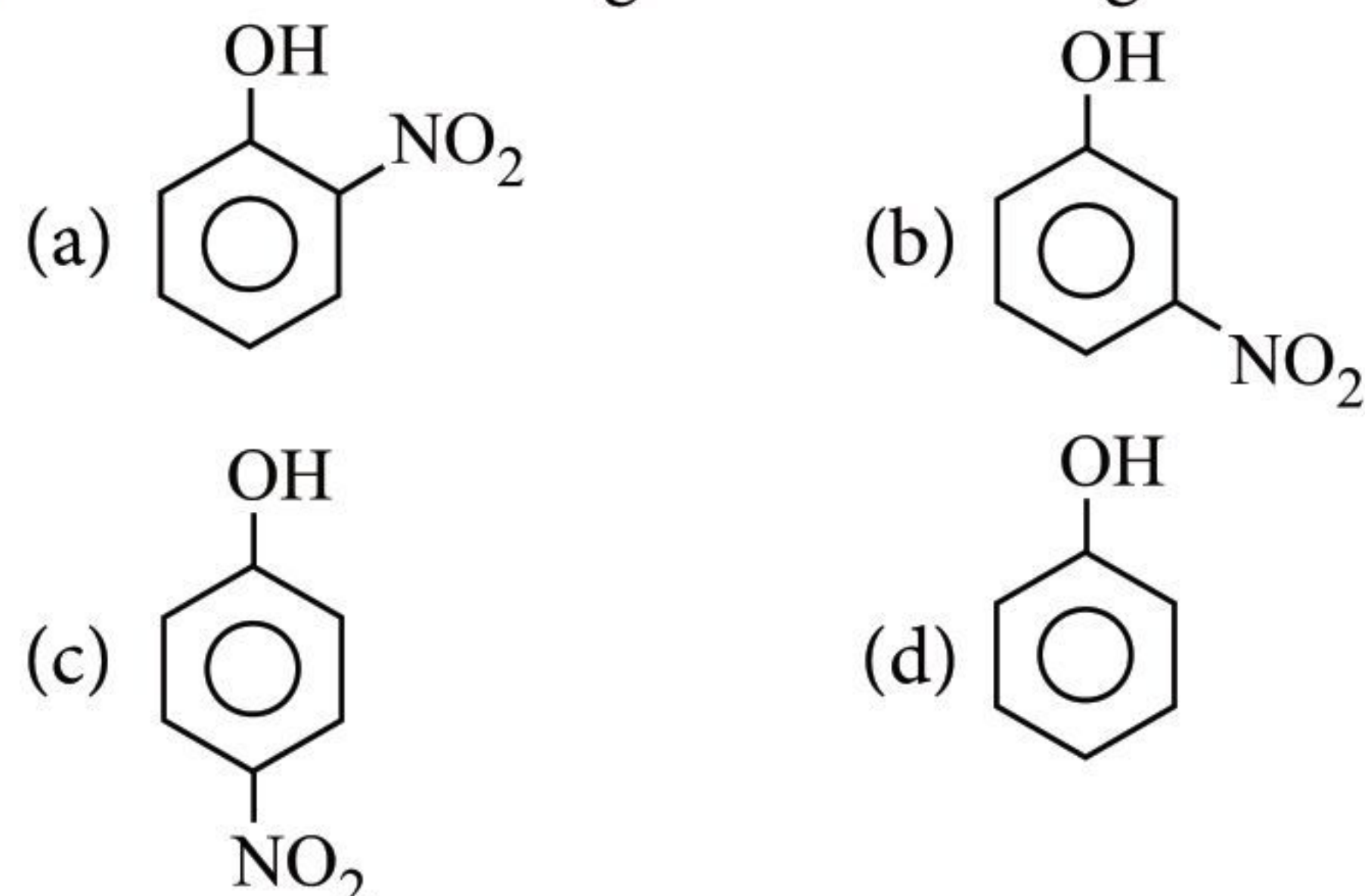


- (a) II > IV > I > III (b) IV > II > III > I
(c) III > II > IV > I (d) IV > I > II > III

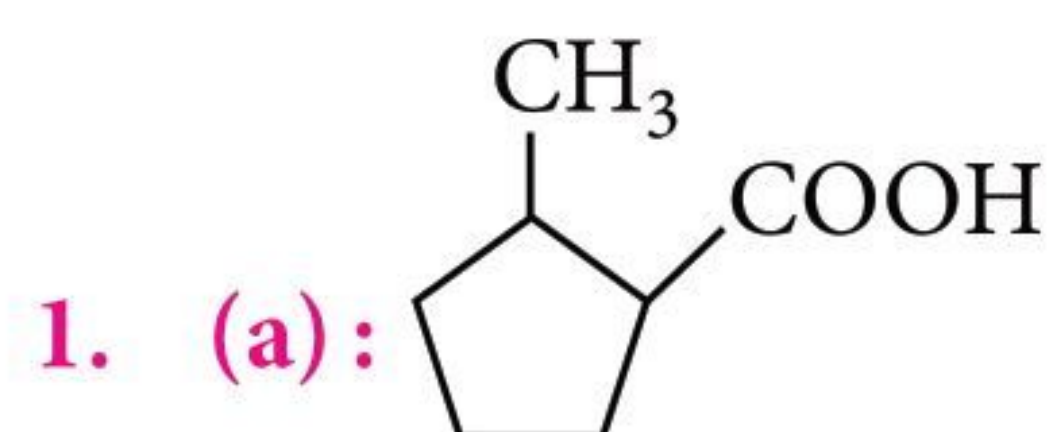
49. The compound that does not liberate CO_2 , on treatment with aqueous sodium bicarbonate solution is

- (a) benzoic acid
(b) benzenesulphonic acid
(c) salicylic acid
(d) carbolic acid.

50. Most acidic amongst the following is



SOLUTIONS



2-methylcyclopentane carboxylic acid

2. (c): Solubility changes with temperature. A plant cell shrinks in hypertonic solution. Relative lowering of vapour pressure is a colligative property.

3. (c): Lyophilic sols are more stable than lyophobic sols because lyophilic sols are extensively solvated *i.e.*, colloidal particles are covered by sheath of the liquid in which they are dispersed.

4. (d)

5. (b): (i) will react faster because a tertiary carbocation will be more stable.

(ii) will react faster due to greater stability of a secondary carbocation.

6. (d)

7. (c): Detergents are sodium or potassium salts of sulphonic acids. Detergents can also be ammonium salts of amines with acetates, chlorides or bromides as anions.

8. (c): $\text{Fe}^{3+} - 3d^5$ No. of unpaired electrons = 5
 $\text{Cr}^{3+} - 3d^3$ No. of unpaired electrons = 3
 $\text{Ni}^{2+} - 3d^8$ No. of unpaired electrons = 2
 $\text{Cu}^{2+} - 3d^9$ No. of unpaired electrons = 1

9. (d): No. of X atoms = $\frac{1}{8} \times 8 = 1$

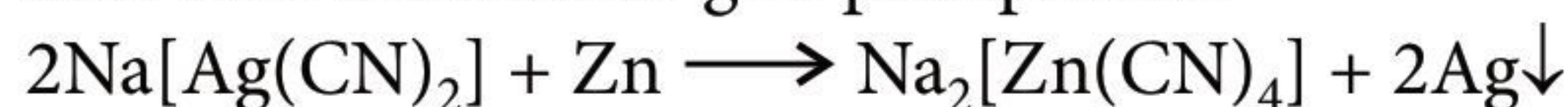
No. of Y atoms (fcc) = $6 \times \frac{1}{2} = 3$

Hence, the formula is XY_3 .

10. (d)

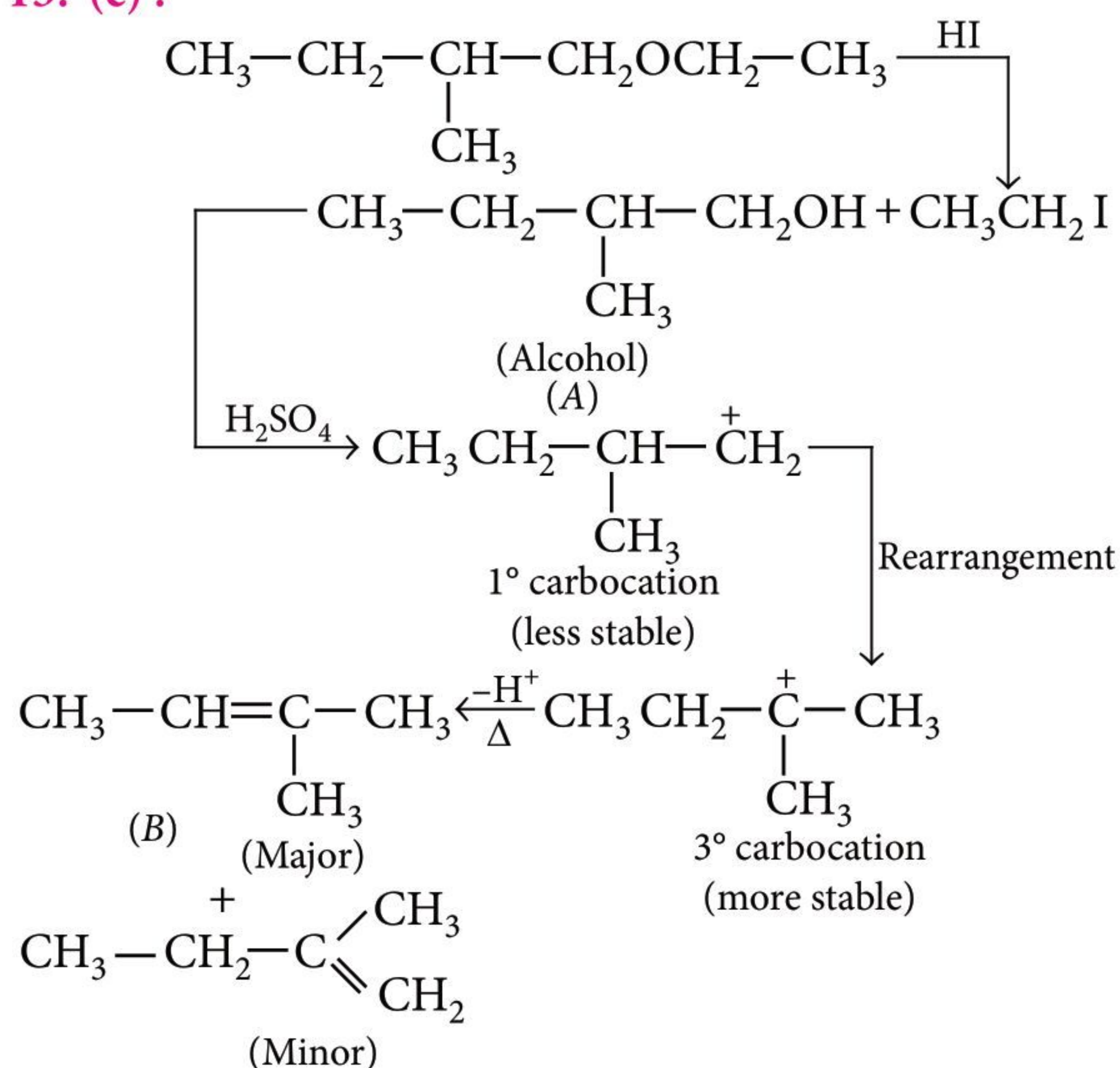
11. (c): Silver is obtained by leaching its ore with dil. cyanide solution. The powdered argentite ore is agitated with a dilute solution of NaCN (0.5%) while a current of O_2 is constantly passed. The metallic silver or silver from the ore dissolves forming sodium argentocyanide.
 $2\text{Ag}_2\text{S} + 8\text{NaCN} + \text{O}_2 + 2\text{H}_2\text{O} \rightleftharpoons 4\text{Na}[\text{Ag}(\text{CN})_2] + 4\text{NaOH} + 2\text{S}$

The soluble silver complex is filtered and treated with zinc dust when silver gets precipitated.



12. (a)

13. (c):



14. (c): At cathode: $\text{Ag}^+ + e^- \rightarrow \text{Ag}$; $E^\circ = +0.80 \text{ V}$

At anode: $\text{Pb} \rightarrow \text{Pb}^{2+} + 2e^-$; $E^\circ = +0.13 \text{ V}$

$$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = 0.80 - 0.13 = 0.67 \text{ V}$$

CONCEPT MAP

EQUILIBRIUM

Ionic Equilibrium

- When ions are involved in equilibrium

Physical Equilibrium

- No new substance formed.
- Solid – liquid equilibrium, ice – water [kept in thermos flask at 0°C]
- Liquid vapour equilibrium, $H_2O(l) \rightleftharpoons H_2O_{(vap)}$
- Solid vapour equilibrium, $I_2(s) \rightleftharpoons I_2(g)$ (Vapour)

Properties

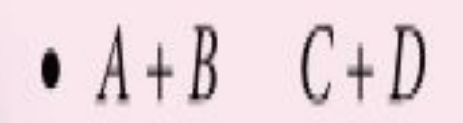
- Dynamic equilibrium
- Concentration remains constant at equilibrium
- Can be approached from each direction
- Reversible

Chemical Equilibrium

- $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$
- $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
- Equilibrium between non-ionic reactants or products.

Law of Chemical Equilibrium and Equilibrium Constant

For a reaction:



Equilibrium constant:

$$K_c = \frac{[C][D]}{[A][B]}$$

Electrolytes

Weak Electrolytes

- The electrolytes which partially dissociate into their ions when dissolved in water.

Strong Electrolytes

- The electrolytes that completely dissociate into their ions when dissolved in water.

Acids, Bases And Salts

- On the basis of Arrhenius concept → Acid → H^+ donor
Base → OH^- donor
- On the basis of Bronsted – Lowry concept:
 - H^+ acceptor → Bronsted base
 - Conjugate acid/base pair → difference of one proton only.
 - H^+ donor — Bronsted acid
- On the basis of Lewis theory

Electron pair acceptor → Lewis acid
Electron pair donor → Lewis base

Ionization of Acids And Bases

Ionic Product of Water

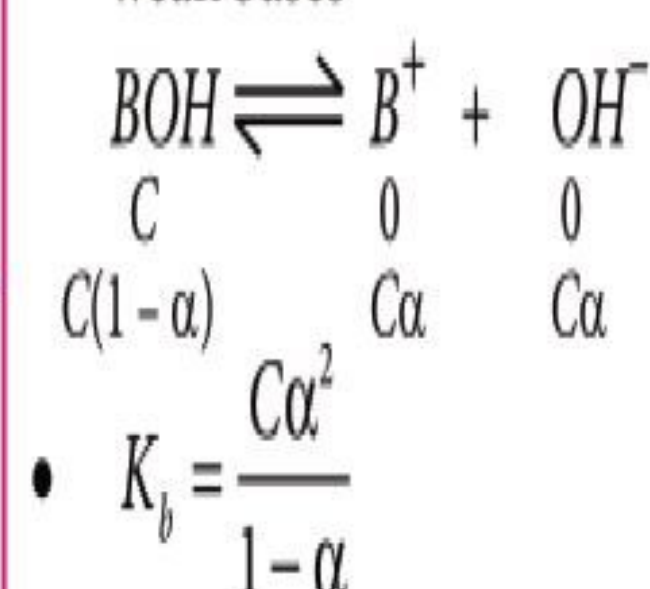
- $K_w = [H^+][OH^-]$
- $K_w = 10^{-14}$ at 298 K
- $[H^+] > [OH^-] \rightarrow$ Acidic
- $[H^+] < [OH^-] \rightarrow$ Basic
- $[H^+] = [OH^-] \rightarrow$ Neutral

- Ionization constant of weak acids
- $$HA \rightleftharpoons H^+ + A^-$$
- $$C \rightleftharpoons 0 + 0$$
- $$C(1-\alpha) \rightleftharpoons \alpha C \rightleftharpoons \alpha C$$
- $$K_a = \frac{\alpha^2}{1-\alpha}$$

pH Scale

- $pH = -\log[H^+]$
- $pH + pOH = pK_w$
- $pH + pOH = 14$

- Ionization constant of weak bases



- Relation between K_a and K_b
- $K_w = K_a \times K_b = 1.0 \times 10^{-14}$
- $pK_w = pK_a + pK_b = 14$

Homogeneous Equilibrium

- All reactants and products are in same state.
- $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

Heterogeneous Equilibrium

- When reactants and products are in different physical states.
- $CaCO_{3(s)} \xrightarrow{\Delta} CaO_{(s)} + CO_{2(g)}$

Common Ion effect

- It is defined as a shift in equilibrium on adding a substance that provides more of an ionic species already present in the dissociation equilibrium.

Hydrolysis of Salts And pH of their Solution

- Salts of weak acid and strong base. e.g., CH_3COONa
 $pH = \frac{1}{2}pK_w + \frac{1}{2}pK_a + \frac{1}{2}\log C$
- Salts of strong acid and weak base e.g., NH_4Cl
 $pH = \frac{1}{2}pK_w - \frac{1}{2}pK_b - \frac{1}{2}\log C$
- Salts of weak acid and weak base, e.g., CH_3COONH_4
 $pH = 7 + \frac{1}{2}(pK_a - pK_b)$

Buffer Solution

- pH changes with temperature as K_w changes.
- Buffer solution resists the change of pH.
- Basic Buffer → Solution of weak base and salt of its conjugate acid.
 $pOH = pK_b + \log \frac{[Salt]}{[Base]}$
- Acidic Buffer → Solution of weak acid and its salt with strong base.
 $pH = pK_a + \log \frac{[Salt]}{[Acid]}$

Solubility Product

- Product of molar concentration of ions of a salt in a saturated solution.
- $M_xX_y \rightleftharpoons xM^{y+} + yX^{x-} \quad K_{sp} = [xM^{y+}]^x [yX^{x-}]^y$
- $K_{sp} = x^x y^y [M^{y+}]^x [X^{x-}]^y$
- Solubility decreases due to common ion effect.

Applications of Equilibrium Constant

- Predicting the extent of a reaction.
- If $K_c > 10^3$ that means product predominates over reactant.
- If $K_c < 10^{-3}$ reactant predominates over product i.e., reaction proceeds rarely.

Negligible Reaction hardly proceeds \rightarrow Extremely large Reaction proceeds almost to completion

- Calculation of equilibrium component composition.

- Predicting the direction of the reaction
- $Q_c =$ ratio of concentration of product to the reactant at any time.
- $Q_c > K_c \Rightarrow$ reaction will proceed in backward direction.
- $Q_c < K_c \Rightarrow$ reaction will proceed in forward direction.
- $Q_c = K_c \Rightarrow$ reaction mixture is at equilibrium.

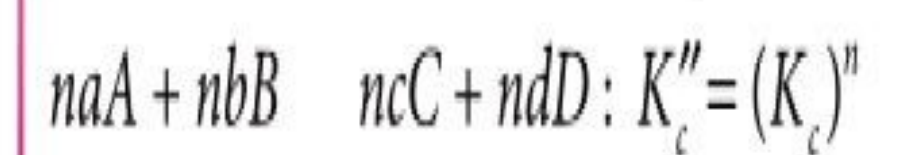
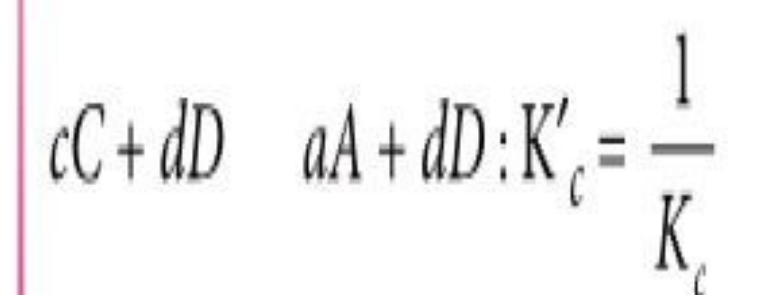
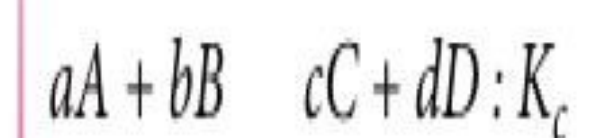
Factors Affecting Equilibria

Le Chatelier's principle

- It states that a change in any of the factors that determine the equilibrium conditions of a system will cause the system to change in such a manner so as to counteract the effect of the change.

- Effect of concentration change
 - Addition of reactant/product — reaction proceeds in the direction in which added amount decreases
 - Removal of reactant/product — reaction proceeds in the direction in which removed amount increases.
- Effect of pressure change
 - Pressure increases — reaction shifts to the side with fewer number of moles of gases.
 - Pressure decreases — reaction shift to the side with higher number of moles of gases.
- Effect of temperature change
 - $\Delta H = -ve$
 - $T \uparrow \rightarrow$ reaction goes backward
 - $T \downarrow \rightarrow$ reaction goes forward
 - $\Delta H = +ve$
 - $T \uparrow \rightarrow$ reaction goes forward
 - $T \downarrow \rightarrow$ reaction goes backward
- Effect of catalyst: Speed up the reactions in both forward as well as backward directions, helps to attain equilibrium faster.

Equilibrium constant for the reverse reaction is the inverse of the equilibrium constant for the reaction in the forward direction.



Equilibrium Constant in Gaseous System

$$K_p = K_c (RT)^{\Delta n}$$

$\Delta n =$ no. of moles of gaseous product – no. of moles of gaseous reactants

Relation between K_c , Q_c and G

- $\Delta G = \Delta G^\circ + RT \ln Q_c$
- $\Delta G^\circ = -RT \ln K_c$
- $K_c = e^{-\Delta G^\circ/RT}$

$$2\text{Ag}^+ + \text{Pb} \rightarrow \text{Pb}^{2+} + 2\text{Ag}$$
$$a = 100, x = 75$$

$$\therefore k = \frac{2.303}{32} \log \frac{100}{100-75} \quad \dots \text{(i)}$$

$$a = 100, x = 50$$

$$k = \frac{2.303}{t} \log \frac{100}{100 - 50} \quad \dots \text{(ii)}$$

$$\frac{2.303}{32} \log \frac{100}{100-75} = \frac{2.303}{t} \log \frac{100}{100-50}$$

$$\text{or } \frac{2.303}{32} \log 4 = \frac{2.303}{t} \log 2$$

$$\text{or } \frac{t}{32} = \frac{\log 2}{\log 4} \quad \text{or } t = \frac{32 \times \log 2}{2 \log 2}$$

$$\therefore t = 16 \text{ min}$$

The electron releasing effect is maximum in tertiary amines and minimum in primary amines (in gas phase).

$$3^\circ \text{ amine} > 2^\circ \text{ amine} > 1^\circ \text{ amine} > \text{NH}_3$$

Triclinic : $a \neq b \neq c$; $\alpha \neq \beta \neq \gamma \neq 90^\circ$

Hexagonal : $a = b \neq c; \alpha = \beta = 90^\circ, \gamma = 120^\circ$

Monoclinic : $a \neq b \neq c$; $\alpha = \gamma = 90^\circ$, $\beta \neq 90^\circ$

18. (d): Mole fraction of solvent (water) = 0.8

Molar mass of $\text{H}_2\text{O} = 18 \text{ g/mol}$

$$\text{No. of moles} = \frac{\text{Given mass}}{\text{Molar mass}}$$

Molality of the aqueous solution

$$= \frac{\text{Moles of solute}}{\text{Mass of solvent in kg}} = \frac{0.2 \times 1000}{14.4} = 13.88 \text{ mol kg}^{-1}$$

19. (d): $\Lambda^\circ(\text{Al}^{3+}) = 3 \Lambda^\circ\left(\frac{1}{3}\text{Al}^{3+}\right)$
 $= 3 \times 63 = 189 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$

$$\begin{aligned}\Lambda^\circ(\text{SO}_4^{2-}) &= 2 \Lambda^\circ\left(\frac{1}{2}\text{SO}_4^{2-}\right) \\ &= 2 \times 80 = 160 \, \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1} \\ \Lambda^\circ[\text{Al}_2(\text{SO}_4)_3] &= 2\Lambda^\circ(\text{Al}^{3+}) + 3\Lambda^\circ(\text{SO}_4^{2-}) \\ &= 2 \times 189 + 3 \times 160 = 858 \, \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}\end{aligned}$$

$$\text{Rate}_1 = k(0.05)^a (0.05)^b = 0.045 \quad \dots(i)$$

$$\text{Rate}_2 = k(0.10)^a (0.05)^b = 0.090 \quad \dots(\text{ii})$$

$$\text{Rate}_3 = k(0.20)^a (0.10)^b = 0.72 \quad \dots(\text{iii})$$

$$\frac{0.090}{0.045} = \frac{(0.10)^a}{(0.05)^a} \Rightarrow 2 = 2^a \Rightarrow a = 1$$
$$\frac{0.72}{0.090} = \frac{(0.20)^a}{(0.10)^a} \frac{(0.10)^b}{(0.05)^b}; \quad 8 = 2^a 2^b \quad (\because 2^a = 2)$$

$$\frac{8}{2} = 2^b \Rightarrow 2^b = 4 \Rightarrow b = 2$$

Thus rate law is, $\text{rate} = k[A][B]^2$

22. (c) : Van Arkel method is used for refining of titanium. Zincite is ZnO. Aniline is a froth stabilizer. Sodium cyanide is used in the metallurgy of Ag.

23. (b): (i) $\text{Mg} + 2\text{HNO}_3 \text{ (5\%)} \rightarrow \text{Mg(NO}_3)_2 + \text{H}_2$
(very dilute) (W)

$$\text{(ii) } 3\text{Cu} + 8\text{HNO}_3 \rightarrow 3\text{Cu}(\text{NO}_3)_2 + 2\text{NO} + 4\text{H}_2\text{O}$$

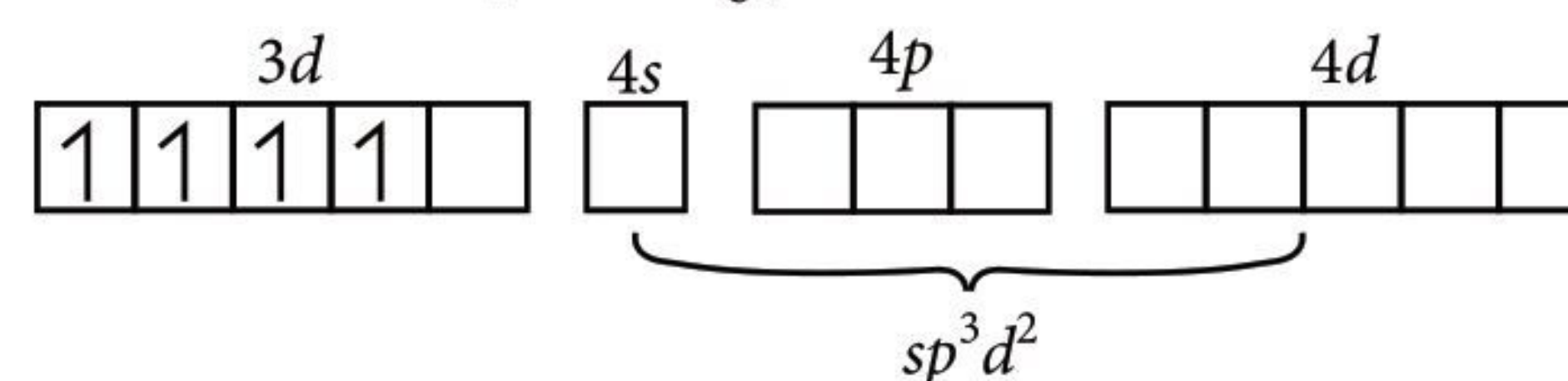
(dil.)
(X)

$$\text{(iii) } \underset{\text{(excess)}}{8\text{NH}_3} + 3\text{Cl}_2 \rightarrow \underset{\text{(Y)}}{6\text{NH}_4\text{Cl}} + \text{N}_2$$
$$\text{(iv) } \text{I}_2 + 10\text{HNO}_3 \rightarrow 2\text{HIO}_3 + 10\text{NO}_2 + 4\text{H}_2\text{O}$$

(Z)

25. (c) : E.C. of Mn^{3+} : $[\text{Ar}] 3d^4$

Mn^{3+} ion in $[\text{MnCl}_6]^{3-}$:



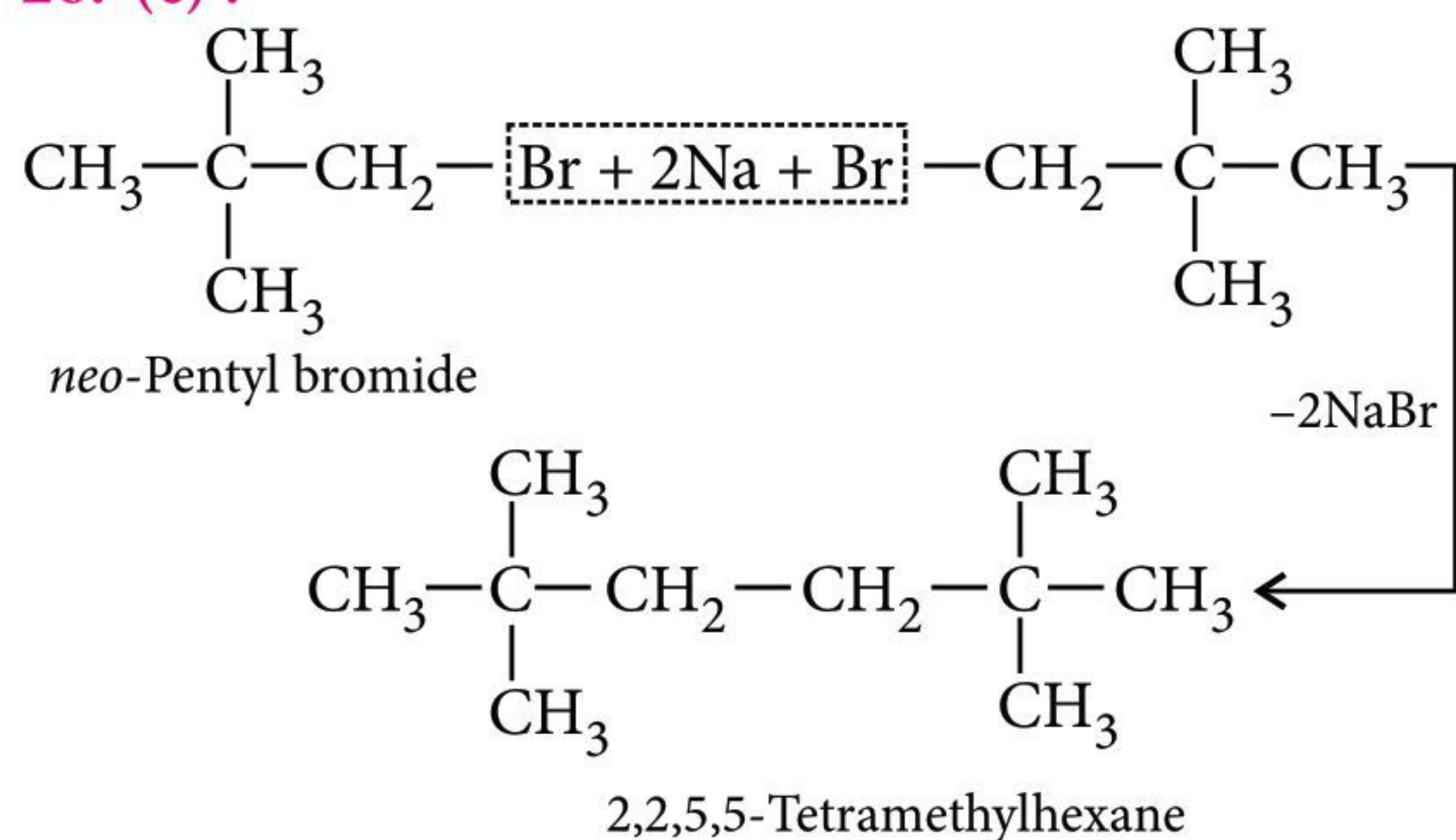
Hybridisation : sp^3d^2 with 4 unpaired electrons.

Quotable Quote

"Dream is not the thing you see in sleep but is that thing which doesn't let you sleep."

A.P.J. Abdul Kalam

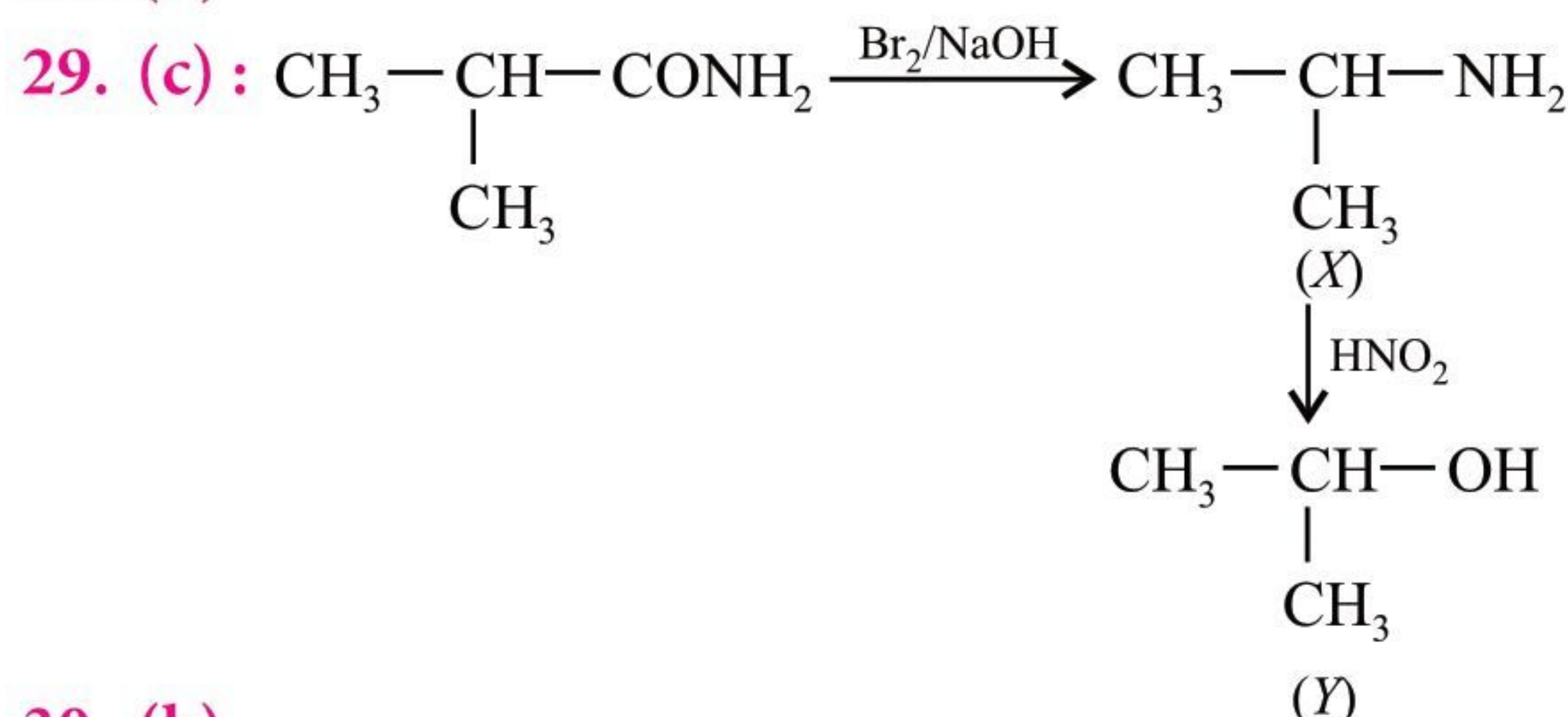
26. (c) :



27. (c) : The rate of reaction with Lucas reagent is $3^\circ > 2^\circ > 1^\circ$.

Tertiary alcohols immediately react to give turbidity, secondary alcohols give turbidity after some time and primary alcohols do not give turbidity until heated.

28. (b)



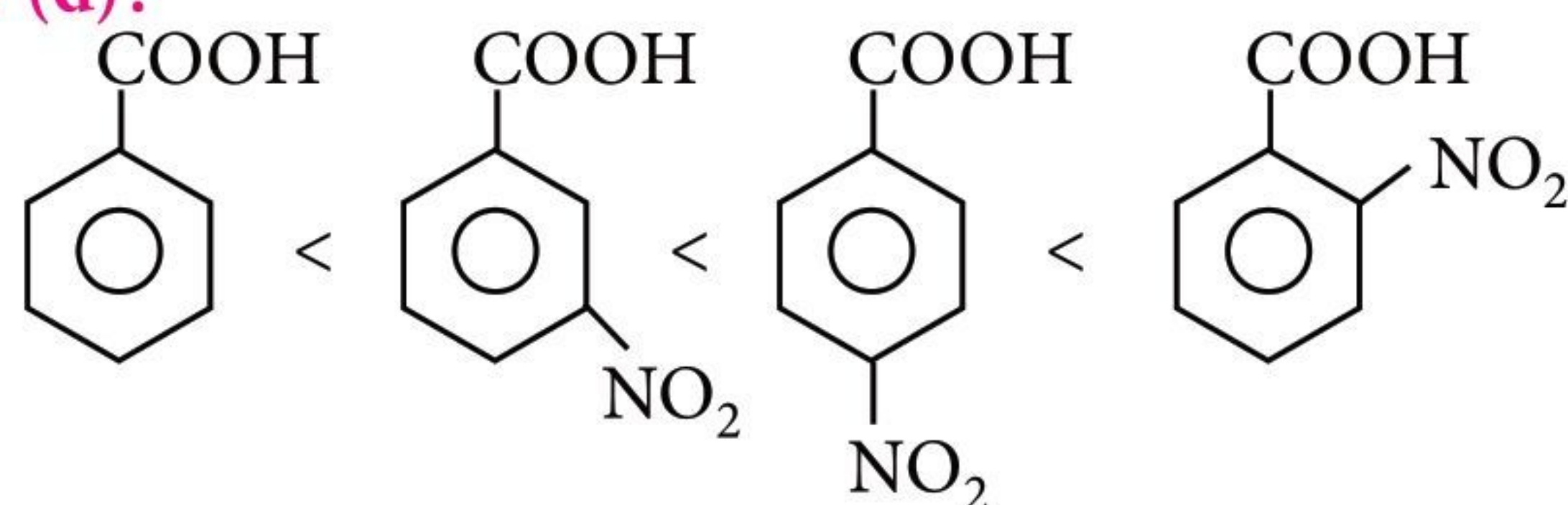
30. (b)

31. (d) : Bakelite is formed by electrophilic substitution reaction of phenol with formaldehyde followed by loss of water (dehydration).

32. (a) : Various types of tranquilizers function by different mechanisms. For example, noradrenaline is one of the neurotransmitter. If the level of noradrenaline is low, then the signal-sending activity becomes low and the person suffers from depression. In such situation, person requires antidepressant drugs. These drugs inhibit the enzymes which catalyse the degradation of noradrenaline. Due to this, level of neurotransmitter becomes normal, it can activate its receptor for longer periods of time, thus counteracting the effect of depression.

33. (a) : Homoleptic complexes have only one type of ligands. In complex $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$, NH_3 serves as the only ligand.

34. (d) :



Electron withdrawing group increases the acidity of benzoic acid, *o*-isomer will have higher acidity than corresponding *m* and *p* isomer due to *ortho*-effect.

As $-\text{NO}_2$ at *p*-position have more pronounced electron withdrawing effect ($-R$ effect) than the $-\text{NO}_2$ group at *m*-position ($-I$ effect).

\therefore Correct order of acidity is $\text{ii} > \text{iii} > \text{iv} > \text{i}$.

35. (a)

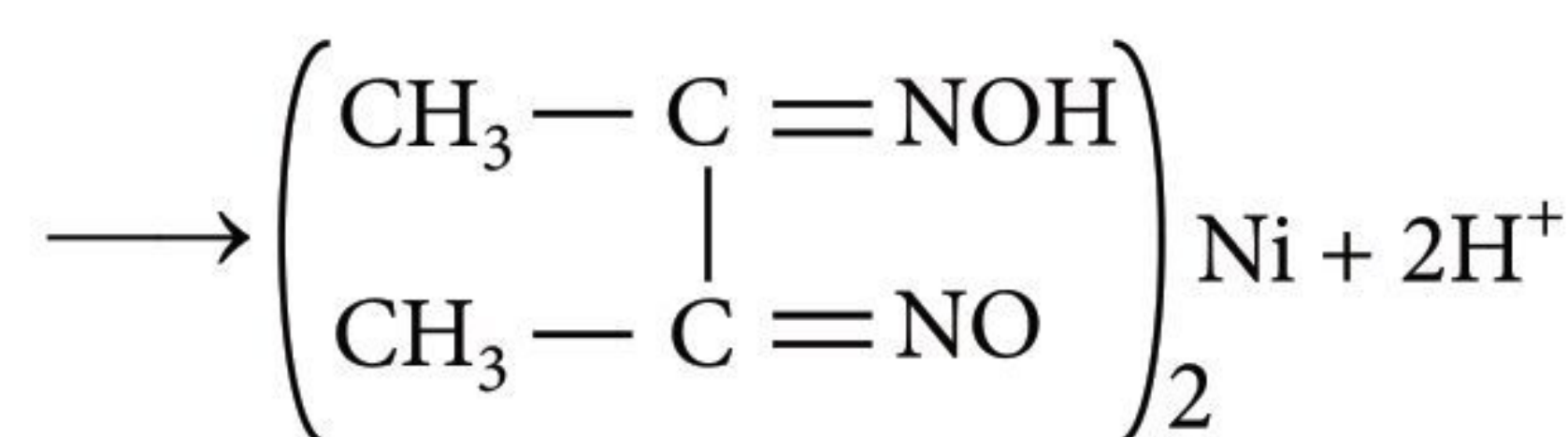
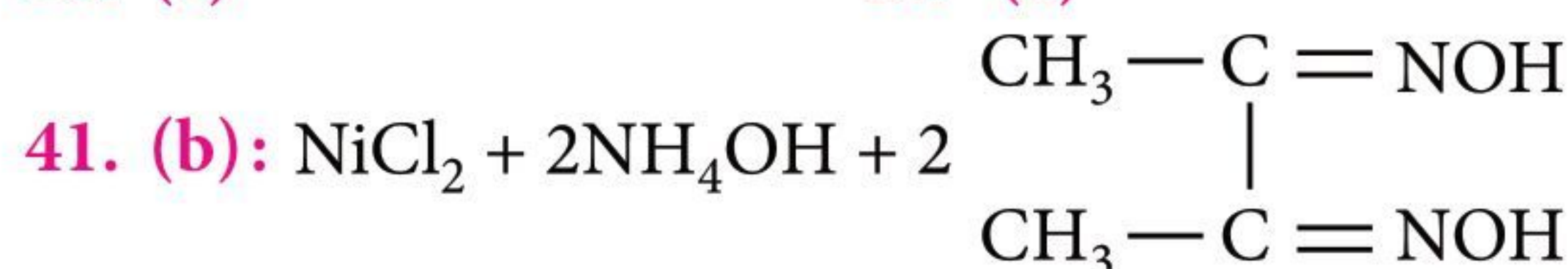
36. (a)

37. (b)

38. (c) : Nitro group is an electron withdrawing group which leads to weakening of $\text{C}-\text{Cl}$ bond, hence making it easier to replace the $-\text{Cl}$ group.

39. (c)

40. (a)



42. (c)

43. (b)

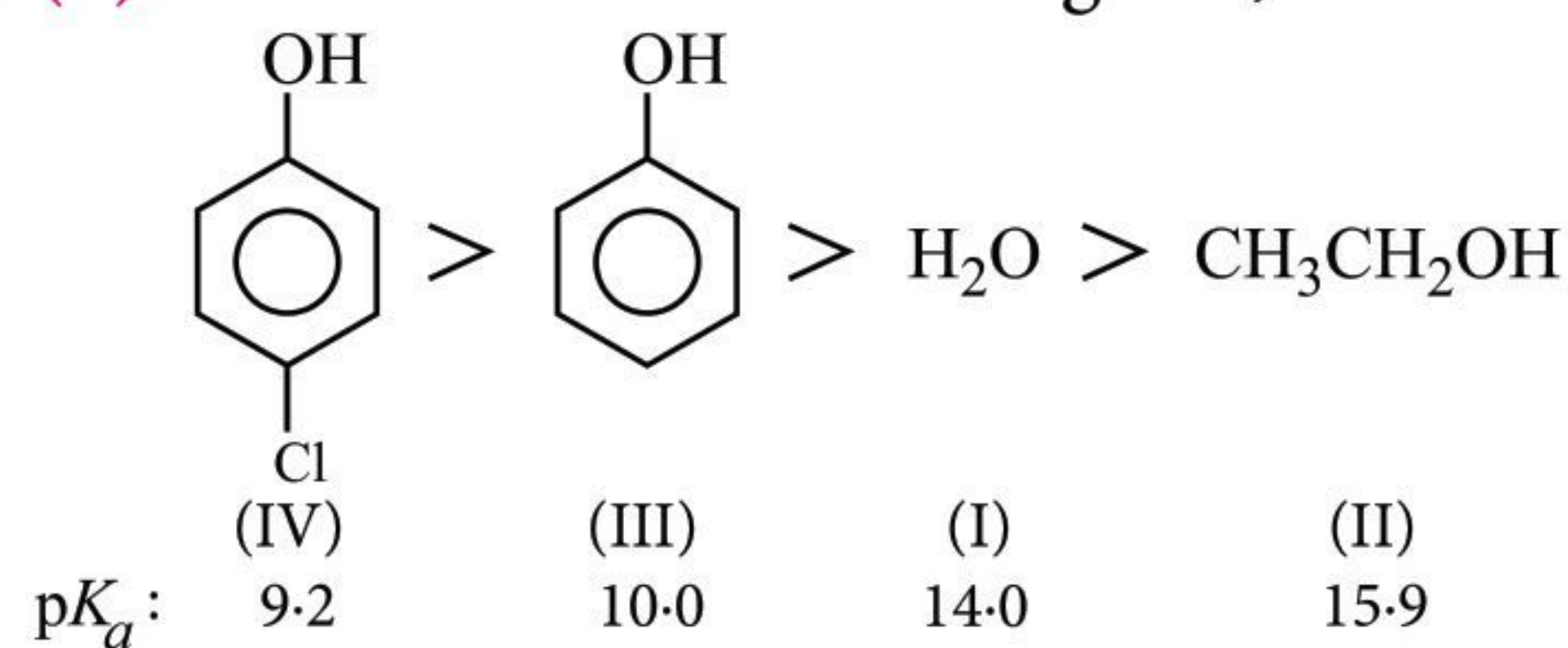
44. (d) : It has no unpaired electrons hence, it is diamagnetic.

45. (d) : (a) and (b) are coordination compounds hence cannot give free Fe^{2+} or Fe^{3+} ions in solution.

(c) and (d) represent simple compounds hence are free to give ions in solution, but only $\text{Fe}_2(\text{SO}_4)_3$ contains Fe^{3+} ions. $(\text{NH}_4)_2\text{SO}_4 \cdot \text{FeSO}_4 \cdot 6\text{H}_2\text{O}$ contains Fe^{2+} ions, not Fe^{3+} ions.

46. (d)

47. (b) : The order of acidic strength is,



48. (a) : Weaker acids have higher $\text{p}K_a$.

$-\text{OCH}_3$ at *meta*-position exerts only $-I$ effect, hence increases the acidity.

$-I$ effect order : $-\text{NO}_2 > -\text{OCH}_3 > -\text{Cl}$.

$-\text{CH}_3$ has $+I$ effect. So, order is (a).

49. (d) : Phenol (Carbolic acid) is a weaker acid than carbonic acid (H_2CO_3) and does not liberate CO_2 on treatment with aqueous sodium bicarbonate solution.

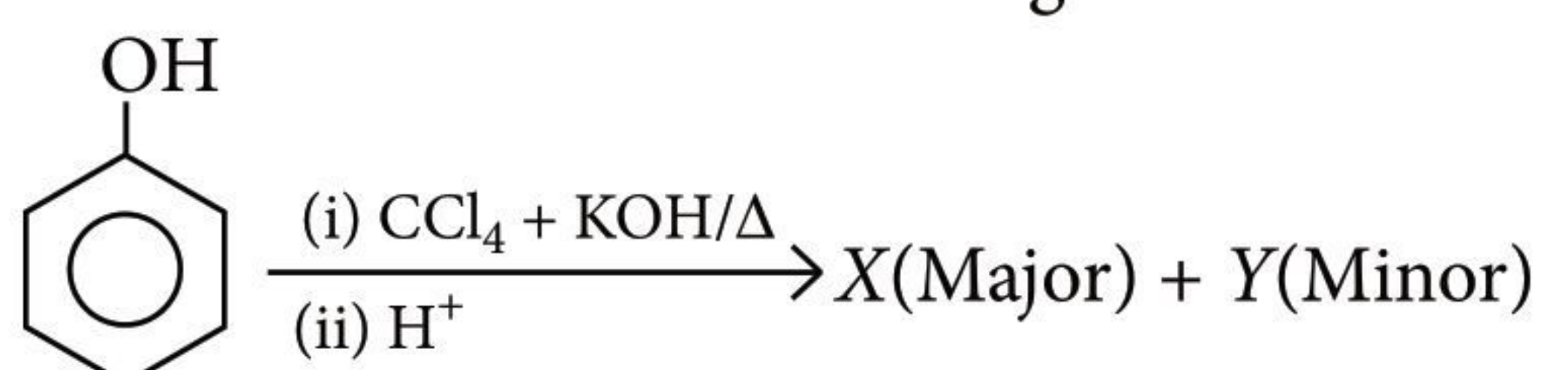
50. (c) : $-\text{NO}_2$ exhibits both $-I$ and $-R$ effects to stabilise the corresponding phenoxide ion. In *ortho* derivative, intermolecular H-bonding lowers the acidity.



JEEWORKCUTS

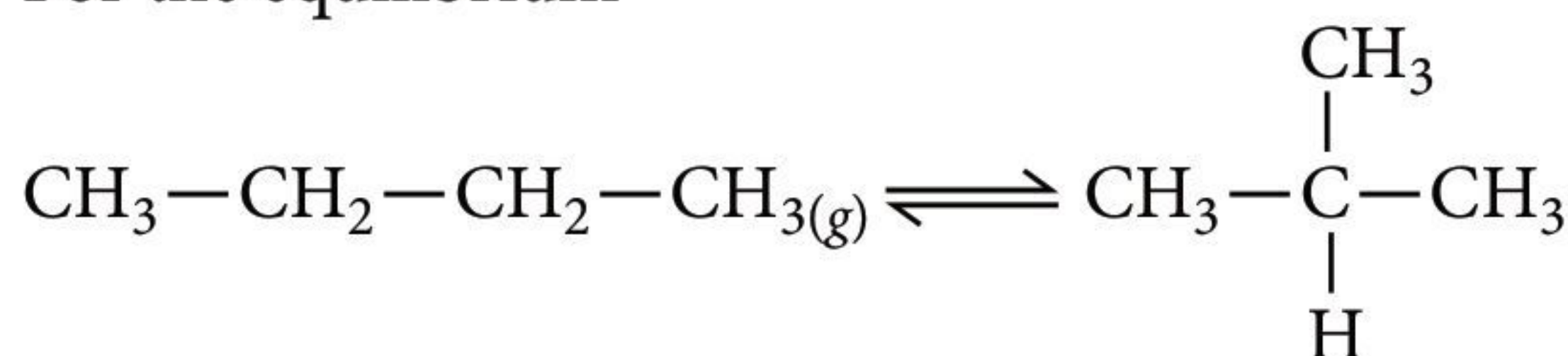
SINGLE OPTION CORRECT TYPE

1. Compare the properties of two isomeric products X and Y formed in the following reaction :

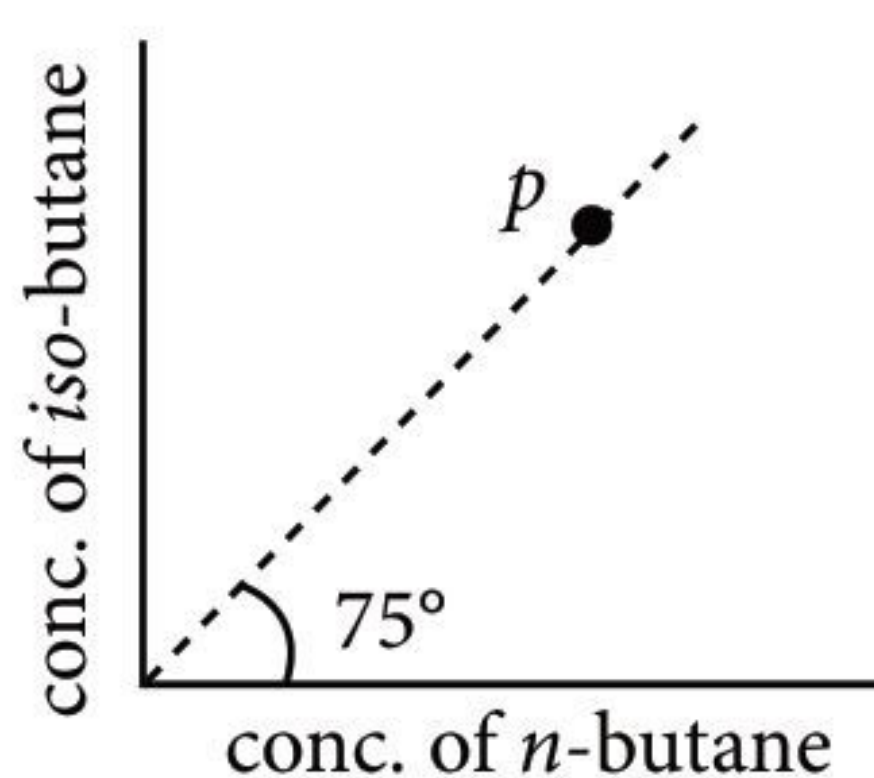


Acidic strength	H ₂ O solubility	Volatility	Melting point
(a) Y > X	Y > X	X > Y	Y > X
(b) X > Y	X > Y	Y > X	X > Y
(c) Y > X	X > Y	Y > X	Y > X
(d) X > Y	Y > X	X > Y	Y > X

2. For the equilibrium



equilibrium constant is found to be 1.732 at 298 K. Now if in a vessel at 298 K, a mixture of these two gases be taken as represented by the point *p* in the figure, predict what will happen?

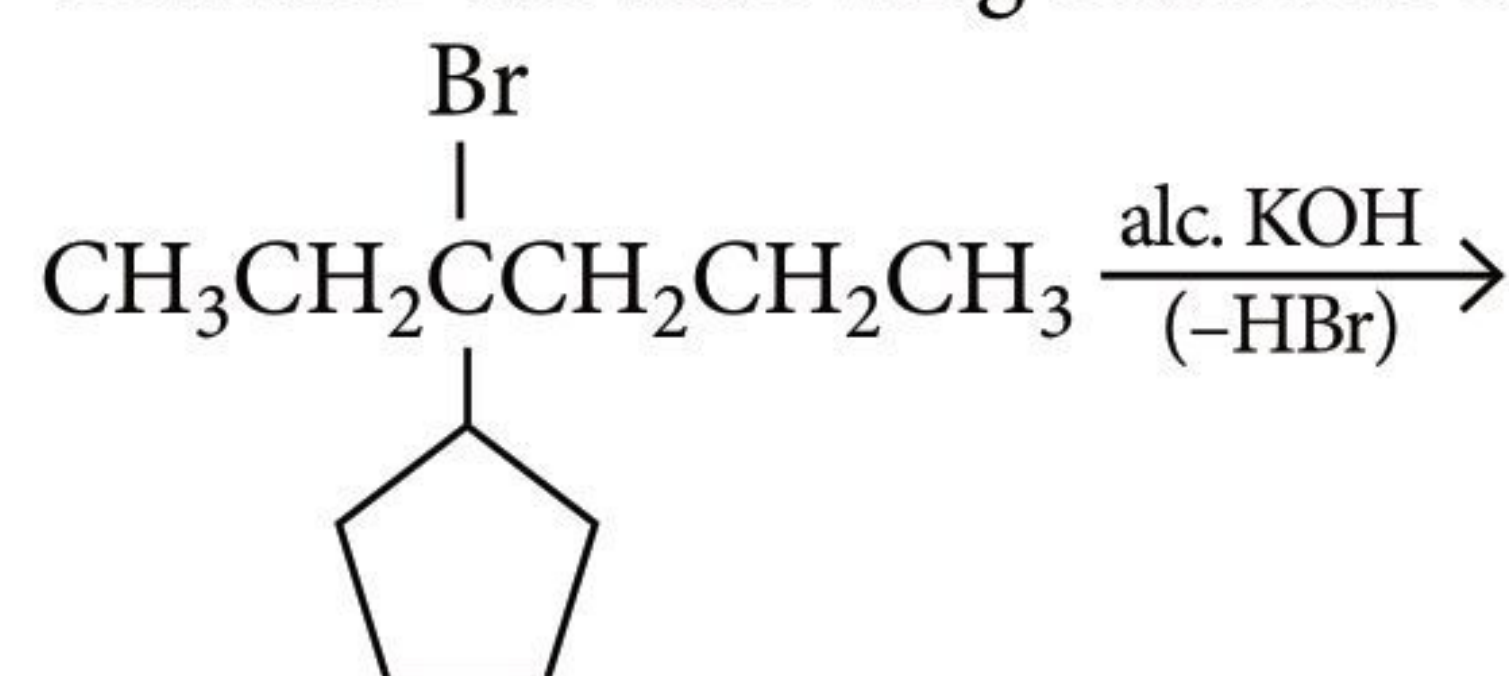


- (a) Immediately equilibrium will be set up.
 (b) The reaction will go in the forward direction till it attains equilibrium.
 (c) The reaction will go in the backward direction till it attains equilibrium.
 (d) Nothing can be said.
3. The ionisation potential of the ground state of hydrogen atom is 2.17×10^{-11} ergs per atom. Calculate the wavelength of the photon that is

emitted when an electron in 3rd Bohr orbit returns to 1st orbit in hydrogen atom.

- (a) 1370 Å (b) 2737 Å (c) 1026 Å (d) 8212 Å

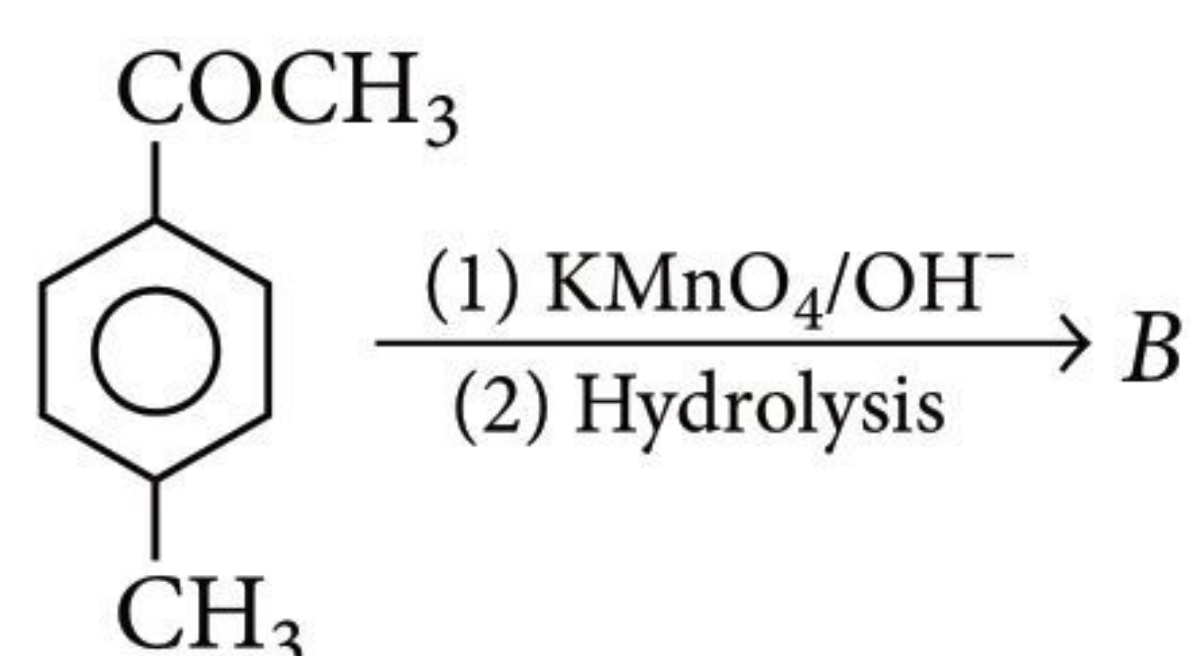
4. Consider the following reactions sequence.



$$\xrightarrow[\text{(ii) Zn/H}_2\text{O}]{\text{(i) O}_3} \text{(mixture of carbonyl compounds)}$$

The incorrect statement is

- (a) total five alkenes are obtained
 (b) total six different carbonyl compounds are obtained on ozonolysis
 (c) all carbonyl compounds can give aldol reaction when treated with dil. KOH
 (d) only two carbonyl compounds give positive iodoform test.
5. $\text{CH}_2=\text{CH}_2 \xrightarrow{\text{Baeyer's reagent}} \text{A}$



Here 'C' is

- (a) glyptal (b) dacron
 (c) nylon-6, 6 (d) nylon-6.

6. If 0.1 M solution of $K_4[Fe(CN)_6]$ is prepared at 300 K then its density is 1.2 g/mL. If solute is 50% dissociated, calculate ΔP of the solution if P of pure water is 25 mm of Hg.

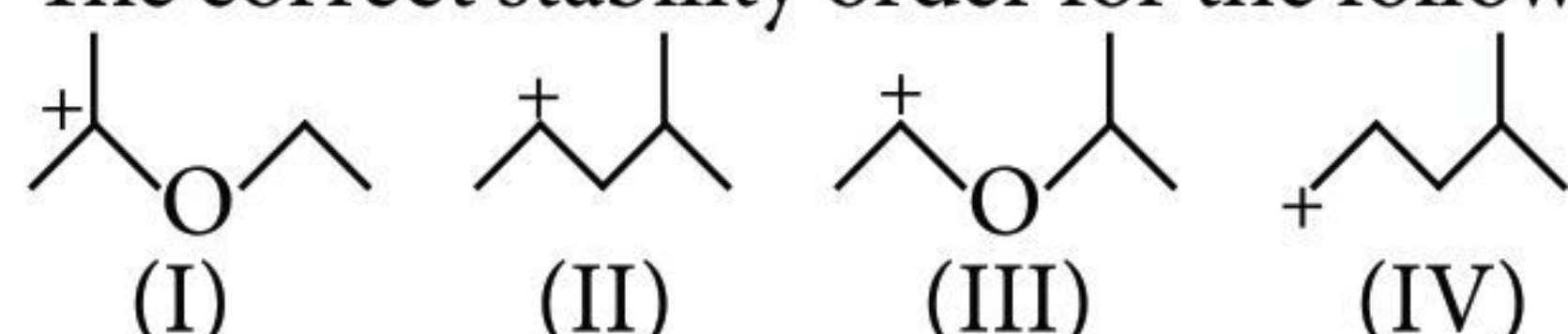
(a) 0.12 (b) 0.20 (c) 10 (d) 0.5

7. Which of the following statements is true for the given sequence of reactions?



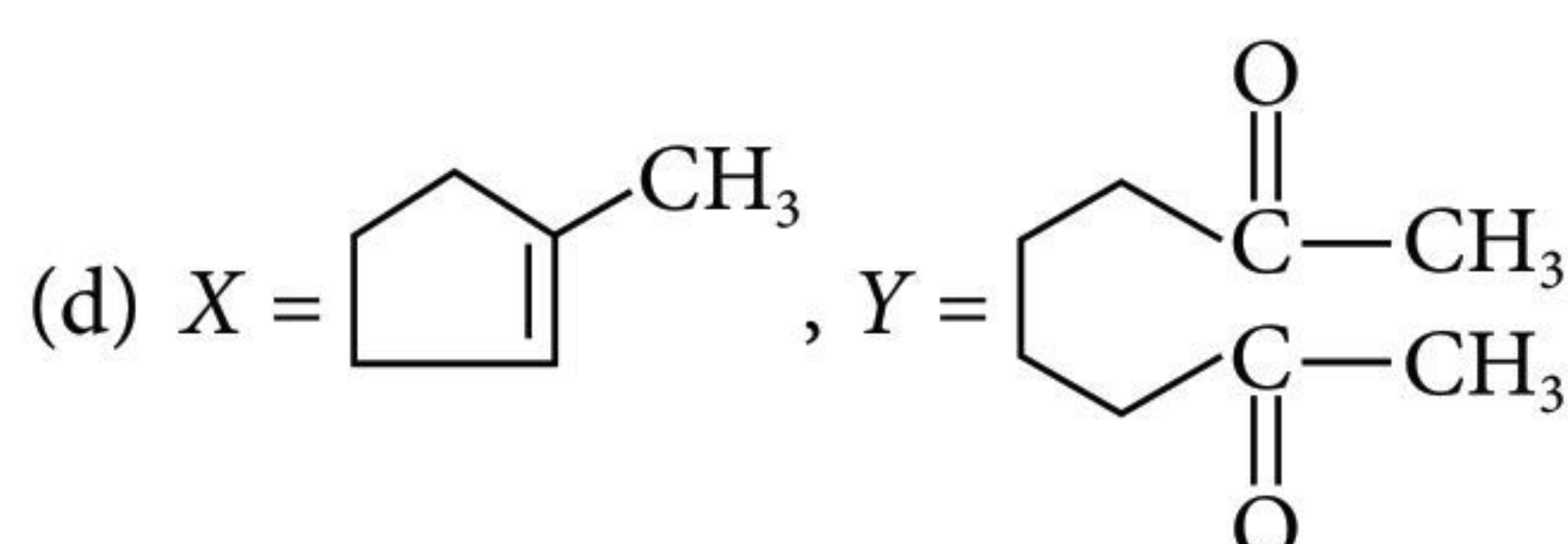
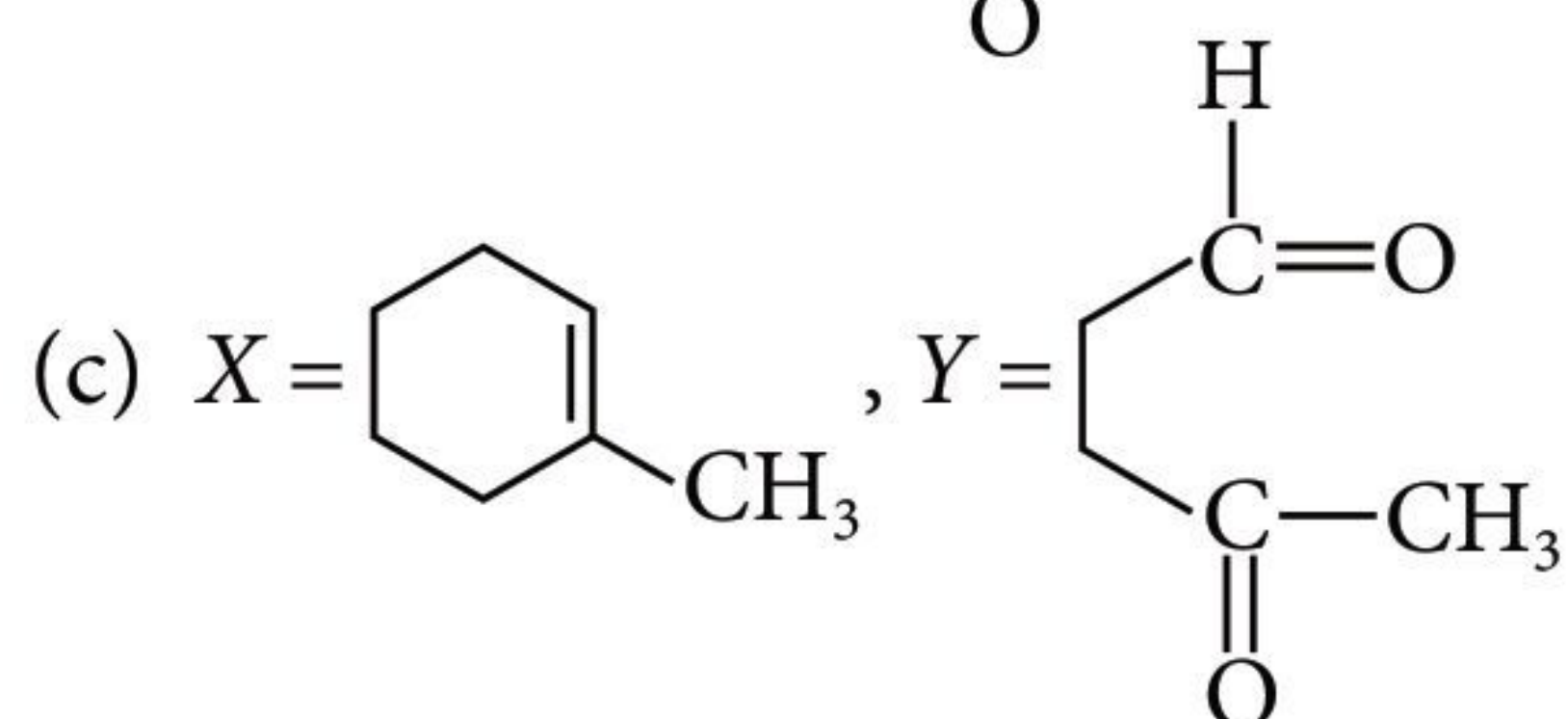
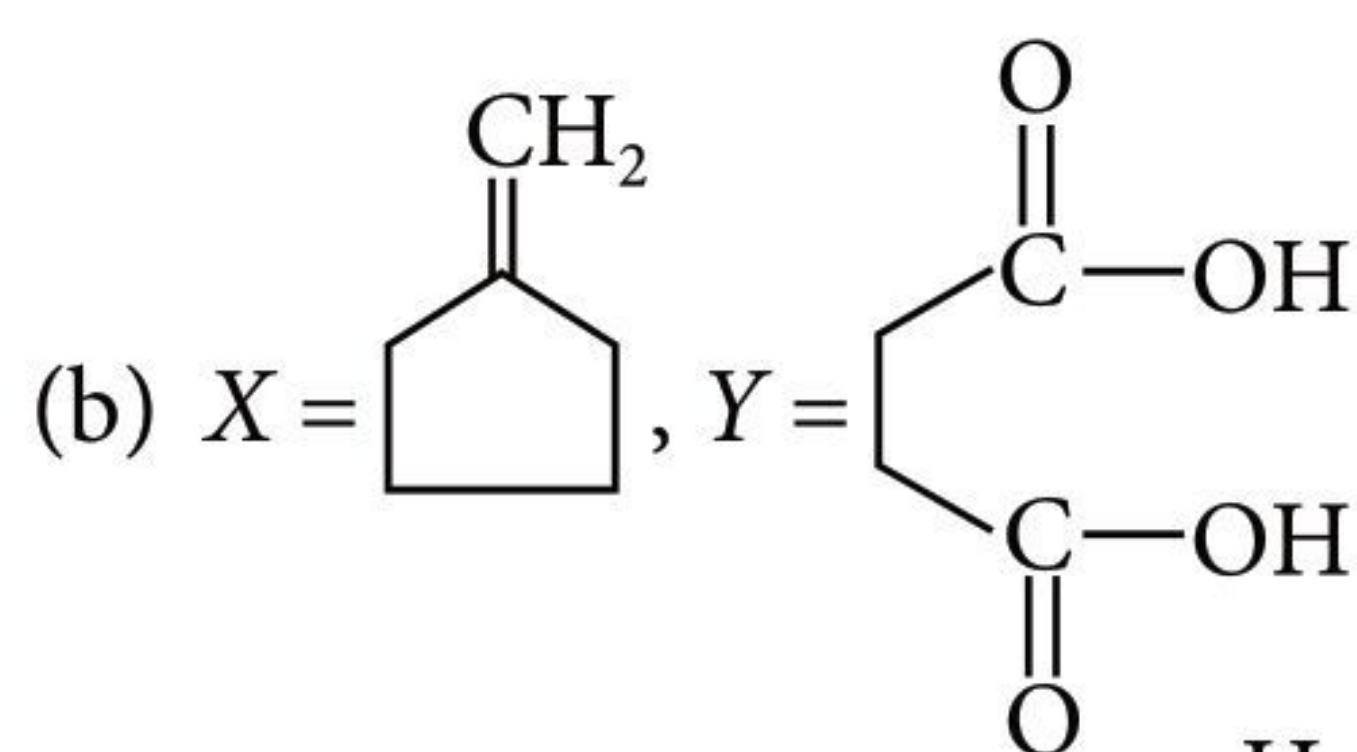
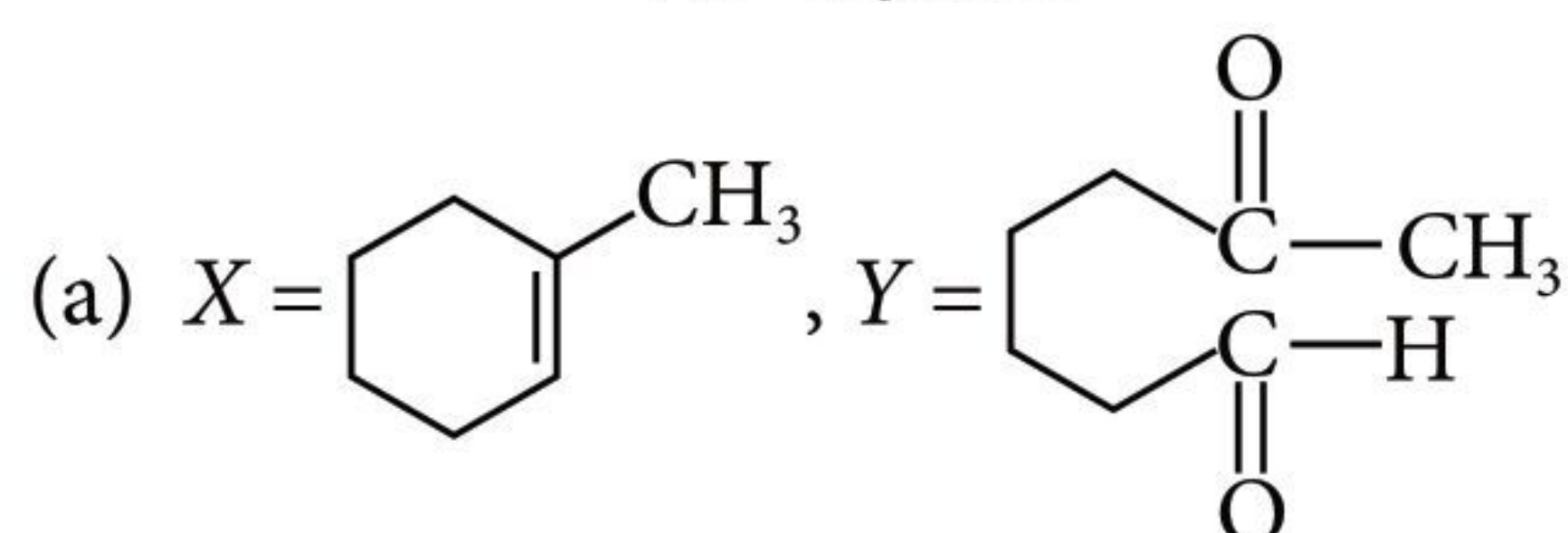
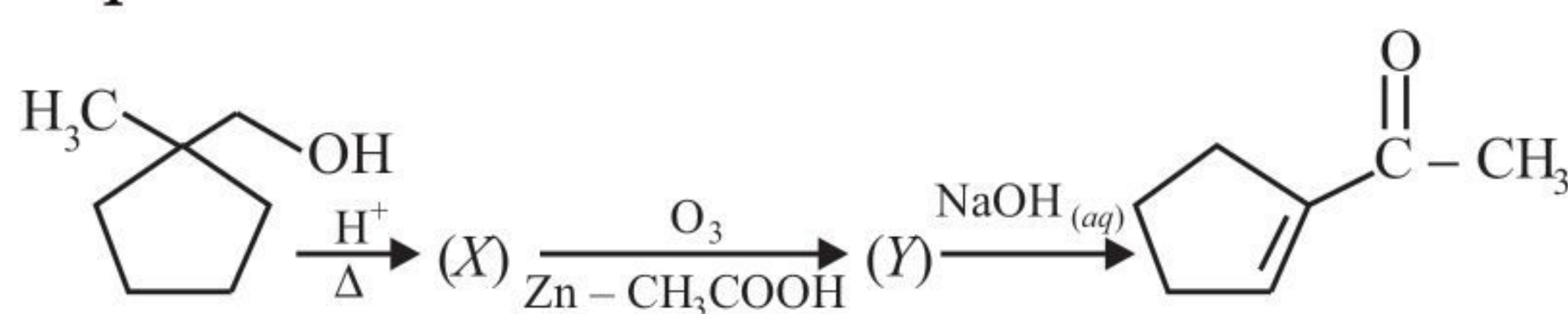
- (a) Z is hydrogen. (b) Y is $NaBH_4$.
(c) Z and Y are F_2 and B_2H_6 respectively.
(d) Z is potassium hydroxide.

8. The correct stability order for the following species is

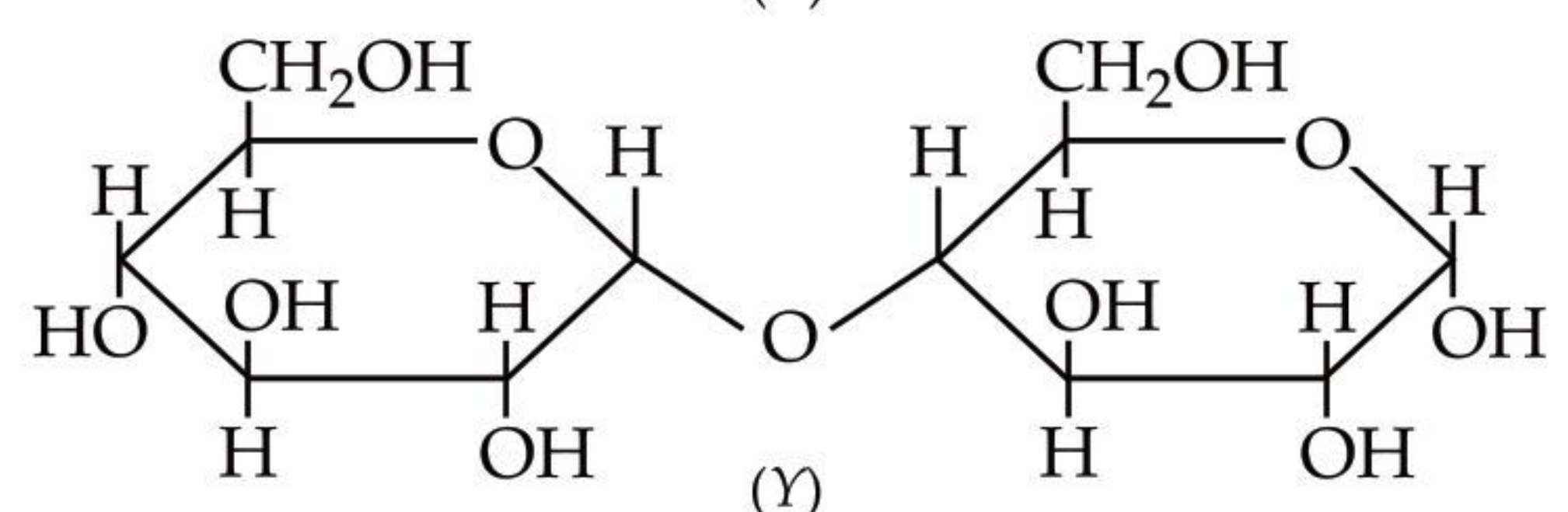
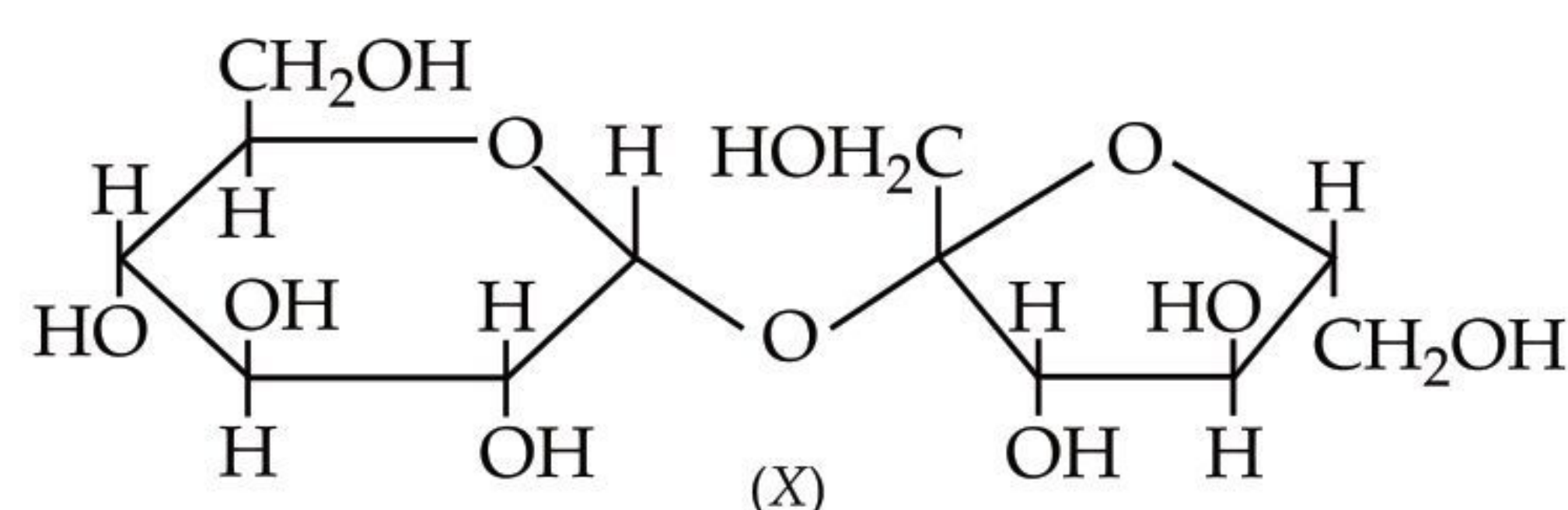


- (a) (II) > (IV) > (I) > (III)
(b) (I) > (II) > (III) > (IV)
(c) (II) > (I) > (IV) > (III)
(d) (I) > (III) > (II) > (IV)

9. Identify (X) and (Y) in the following reaction sequence.

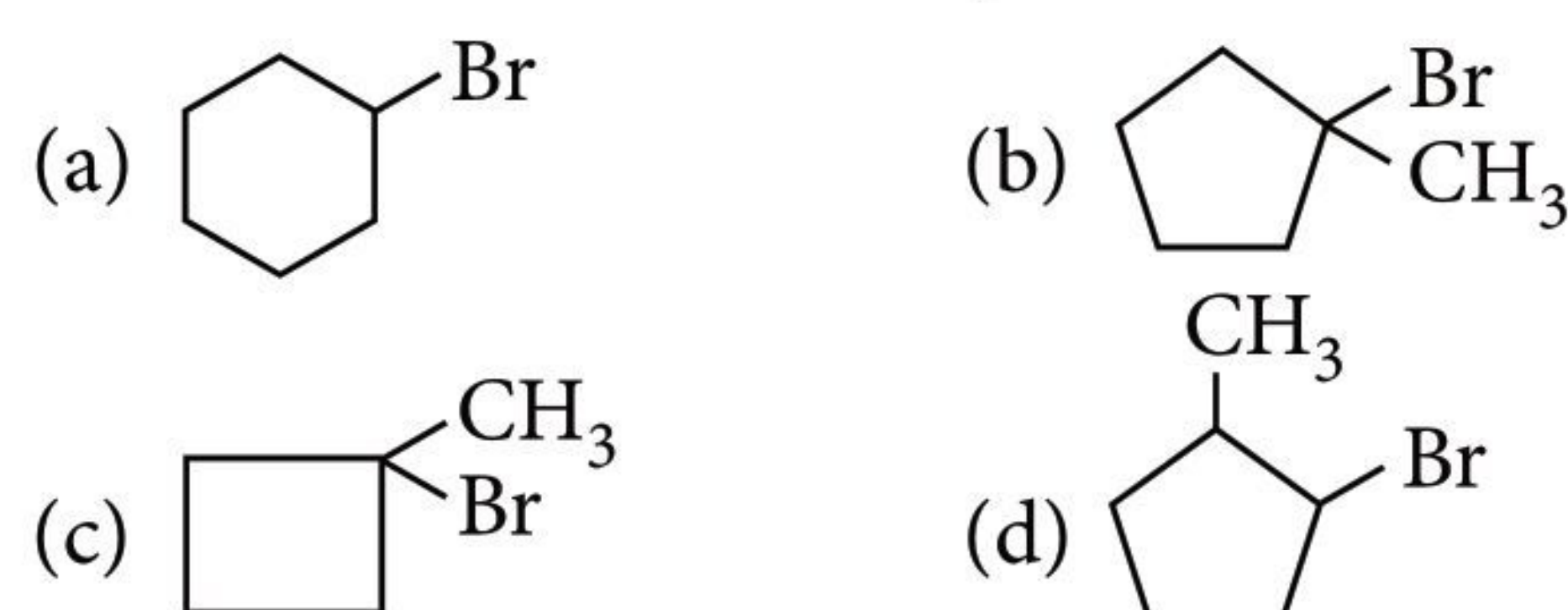
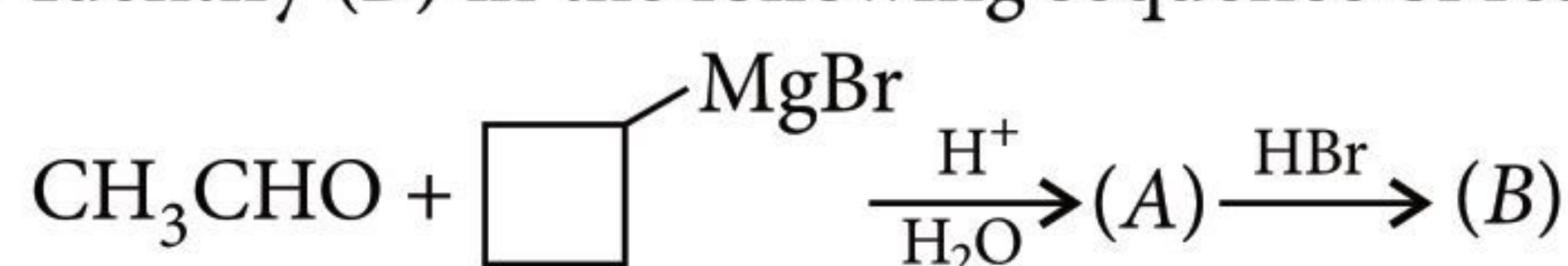


10. Which of the following will not reduce Tollens' reagent?

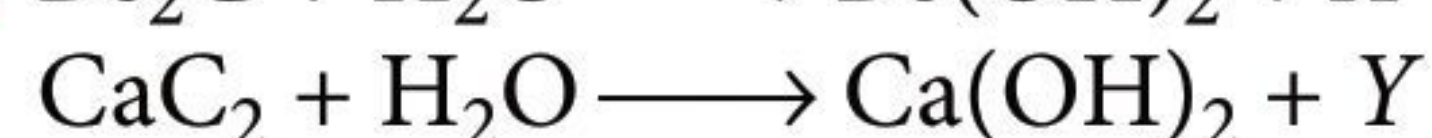


- (a) (X) only (b) (Y) only
(c) Both (X) and (Y) (d) Neither (X) nor (Y)

11. Identify (B) in the following sequence of reactions,



12. $Be_2C + H_2O \longrightarrow Be(OH)_2 + X$

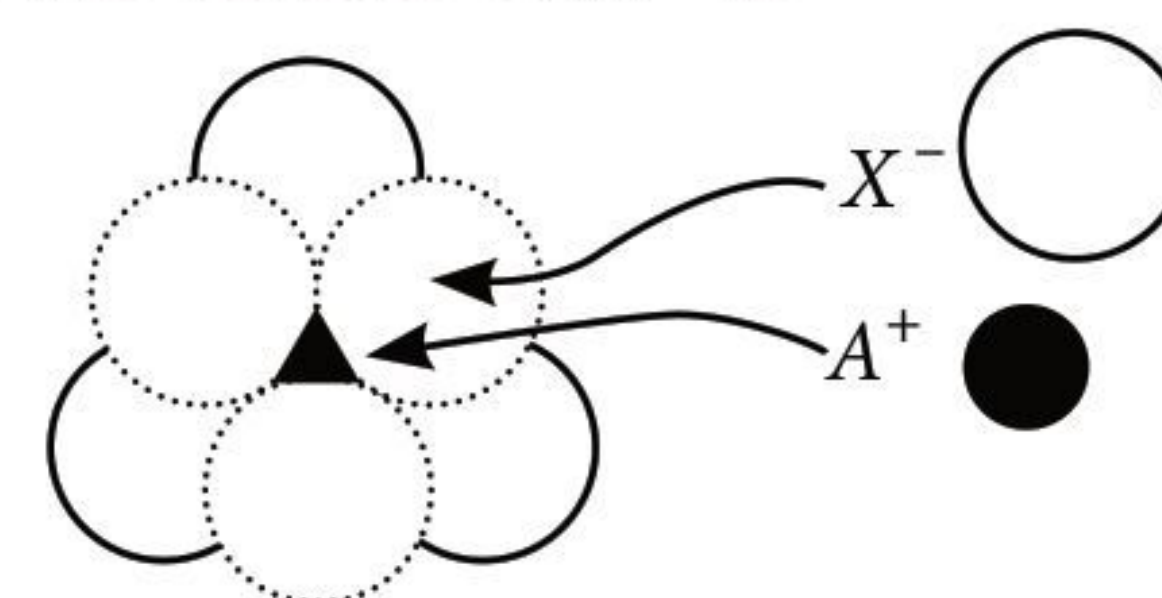


X, Y and Z are respectively

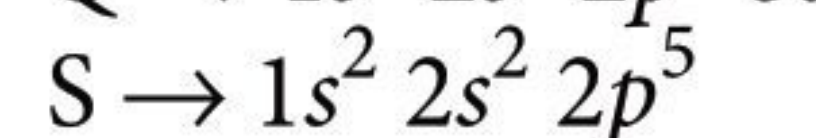
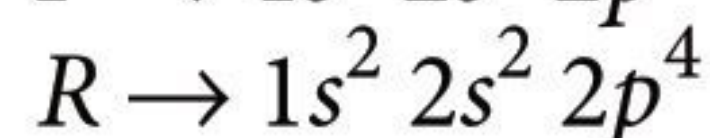
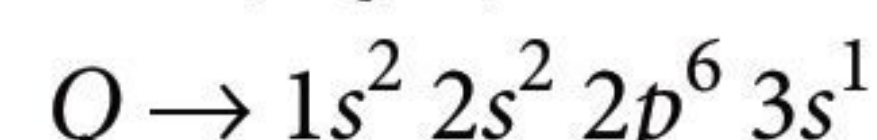
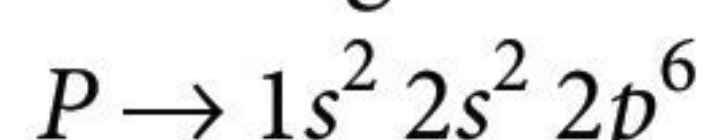
- (a) CH_4 , C_2H_2 , C_3H_8 (b) CH_4 , C_2H_6 , C_3H_8
(c) CH_4 , C_2H_2 , C_3H_4 (d) C_2H_2 , C_2H_6 , C_3H_4

13. The arrangement of X^- ions around A^+ ion in solid AX is given in the figure (not drawn to scale). If the radius of X^- is 250 pm, the radius of A^+ is

- (a) 104 pm
(b) 125 pm
(c) 183 pm
(d) 57 pm.



14. If configurations of elements P, Q, R, S are



Correct order of electron accepting tendency is

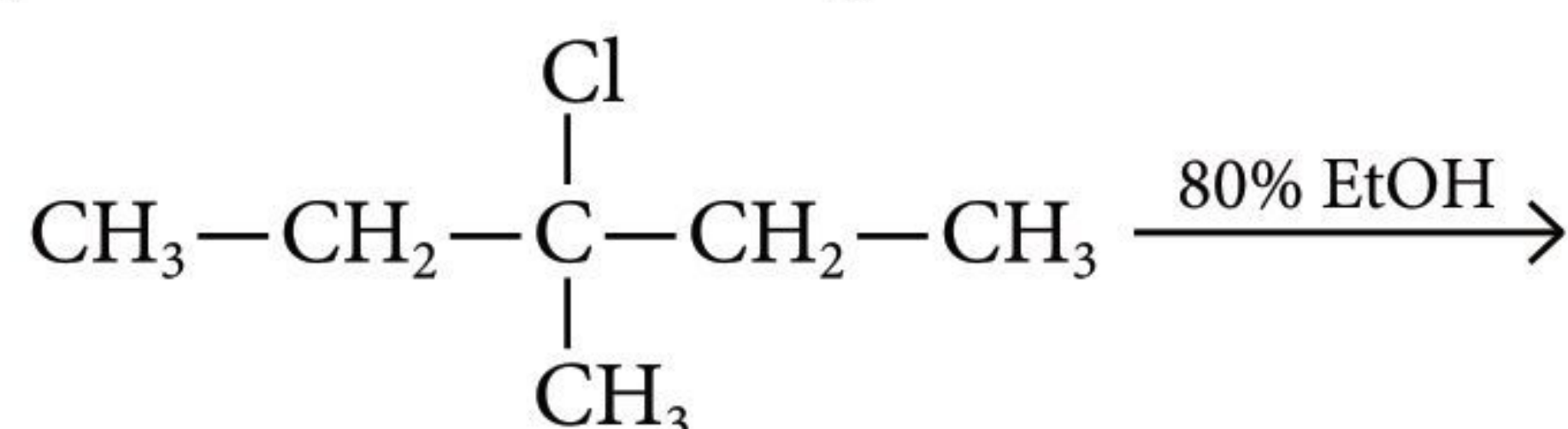
- (a) $P < R < Q < S$ (b) $P < Q < R < S$
(c) $S < R < Q < P$ (d) $S < Q < R < P$

15. Applying Freundlich adsorption isotherm, calculate the amount of acetic acid adsorbed by 1 kg of blood charcoal at 25°C from a 5% vinegar solution (mass/volume). (Given that if the concentration is expressed in molarity (mol dm^{-3}), x/m is mass of the solute adsorbed per gram of adsorbent, then $k = 0.160$ and $n = 2.32$.)

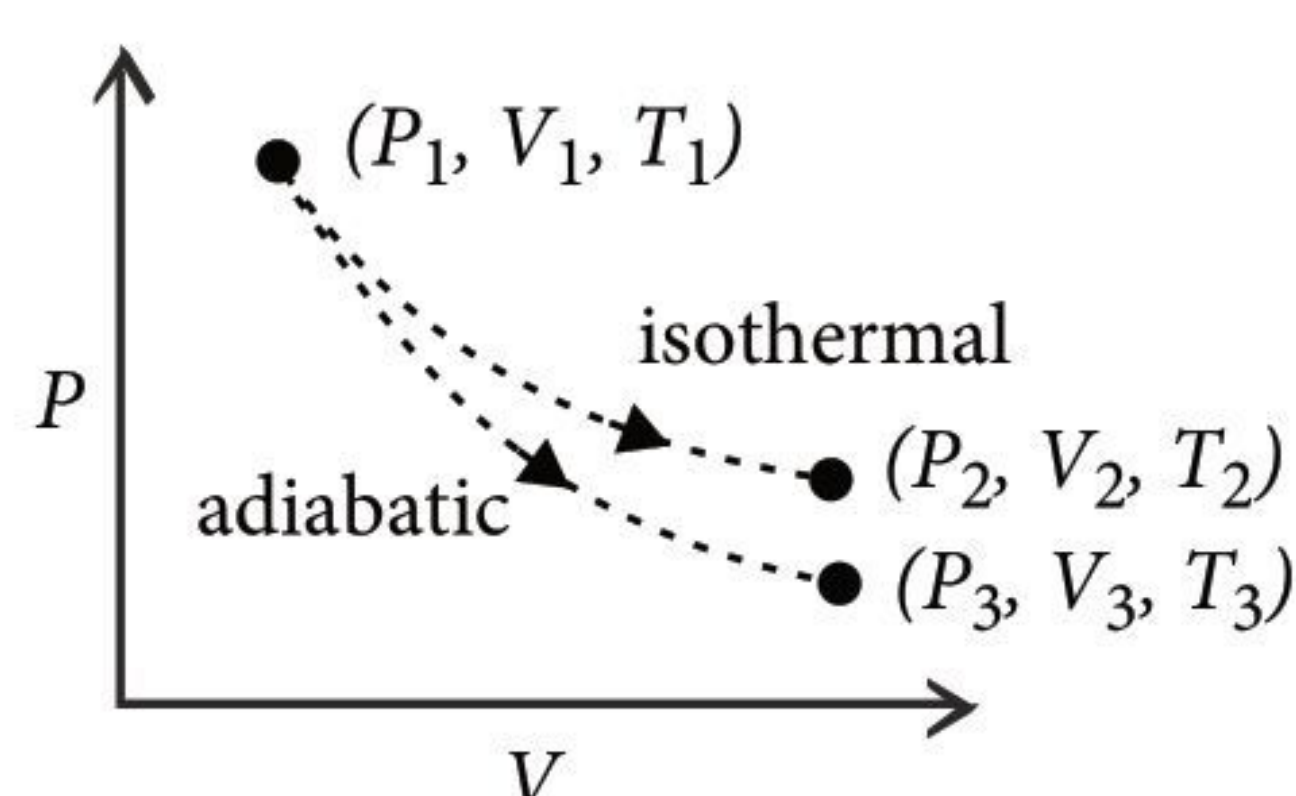
- (a) 147.8 (b) 150.2 (c) 158.1 (d) 140.2

MORE THAN ONE OPTION CORRECT TYPE

16. For the reaction,
 $\text{CrO}_5 + \text{H}_2\text{SO}_4 \longrightarrow \text{Cr}_2(\text{SO}_4)_3 + \text{H}_2\text{O} + \text{O}_2$
 incorrect statement(s) is/are
- oxidation state of Cr in CrO_5 is +8.
 - Four O atoms are present in -1 oxidation state and one O atom is present in -2 oxidation state.
 - in CrO_5 , two peroxide linkages are present.
 - one mole of CrO_5 will liberate 9/4 mole of O_2 .
17. Which of the following are correct on the basis of MOT?
- Bond strength order : $\text{CO} > \text{CO}^+$
 - Bond length order : $\text{O}_2 > \text{O}_2^+ > \text{O}_2^-$
 - Number of unpaired electrons order :
 $\text{O}_2 > \text{NO} > \text{CO}$
 - Number of ABMO electrons order : $\text{O}_2 > \text{N}_2^- > \text{Be}_2$
18. Which of the following statement are true regarding the product formed in the given reaction?



- Major product is given by $\text{S}_{\text{N}}1$ reaction.
 - Through E1 mechanism three alkenes are formed.
 - 3-Methylpentan-3-ol is also formed as one of the product.
 - Fractional distillation of elimination product will give two fractions.
19. The reversible expansion of an ideal gas under adiabatic and isothermal conditions is shown in the figure. Which of the following statement(s) is(are) correct?

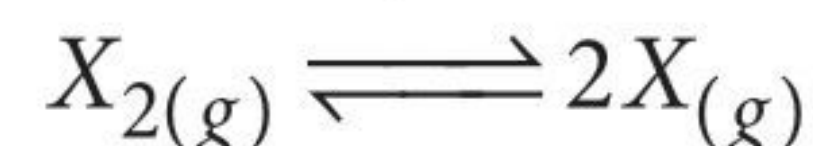


- $T_1 = T_2$
- $T_3 > T_1$
- $w_{\text{isothermal}} > w_{\text{adiabatic}}$
- $\Delta U_{\text{isothermal}} > \Delta U_{\text{adiabatic}}$

PARAGRAPH BASED QUESTIONS

Paragraph for Q. No. 20 and 21

Thermal decomposition of gaseous X_2 to gaseous X at 298 K takes place according to the following equation :



The standard reaction Gibbs energy, $\Delta_r G^\circ$, of this reaction is positive. At the start of the reaction, there is one mole of X_2 and no X . As the reaction proceeds, the number of moles of X formed is given by β . Thus, $\beta_{\text{equilibrium}}$ is the number of moles of X formed at equilibrium. The reaction is carried out at a constant total pressure of 2 bar. Consider the gases to behave ideally. (Given : $R = 0.083 \text{ L bar K}^{-1} \text{ mol}^{-1}$)

20. The equilibrium constant K_p for this reaction at 298 K, in terms of $\beta_{\text{equilibrium}}$, is

- $\frac{8\beta_{\text{equilibrium}}^2}{2 - \beta_{\text{equilibrium}}}$
- $\frac{8\beta_{\text{equilibrium}}^2}{4 - \beta_{\text{equilibrium}}^2}$
- $\frac{4\beta_{\text{equilibrium}}^2}{2 - \beta_{\text{equilibrium}}}$
- $\frac{4\beta_{\text{equilibrium}}^2}{4 - \beta_{\text{equilibrium}}^2}$

21. The incorrect statement among the following, for this reaction, is

- decrease in the total pressure will result in formation of more moles of gaseous X
- at the start of the reaction, dissociation of gaseous X_2 takes place spontaneously
- $\beta_{\text{equilibrium}} = 0.7$
- $K_c < 1$

Paragraph for Q. No. 22 and 23

When compound O is heated with KMnO_4/H^+ , P is produced, which on heating with ammonia gave Q. The compound Q on treatment with Br_2/NaOH produced R. On strong heating, Q gave S, which on further treatment with ethyl 2-bromopropionate in the presence of KOH followed by acidification, gave a compound T.



22. The compound R is

-
-
-
-

23. The compound *T* is
(a) glycine (b) alanine (c) valine (d) serine.

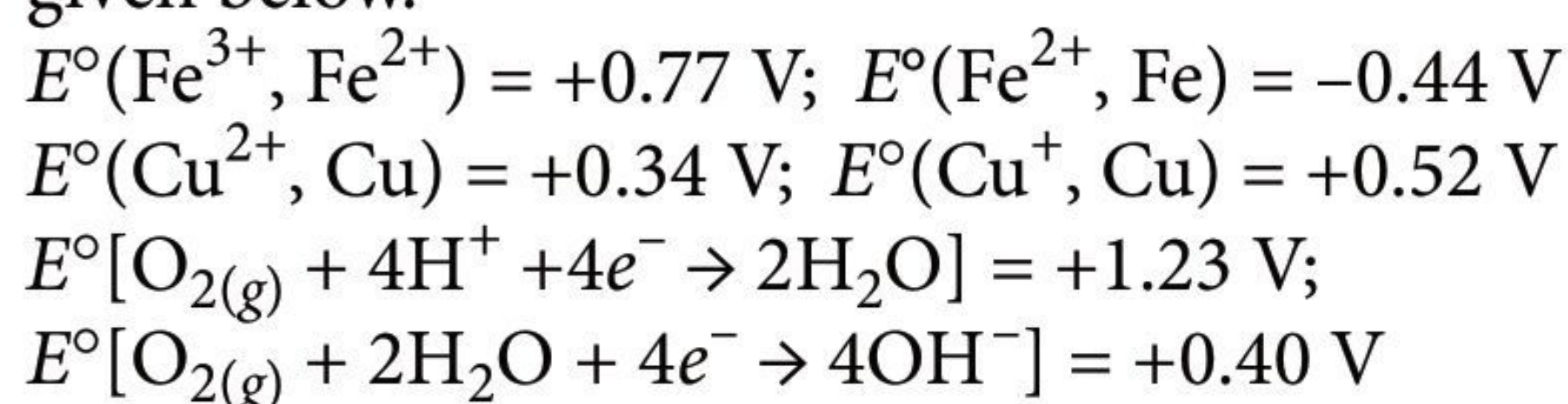
MATCHING LIST TYPE

24. Match the column I with column II and choose the correct option.

Column-I (Pair of complexes)	Column-II (Property which is similar in given pair)
A. $[\text{Fe}(\text{CN})_6]^{3-}$ and $[\text{Co}(\text{NH}_3)_6]^{3+}$	p. Magnetic moment
B. $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Fe}(\text{CN})_6]^{4-}$	q. Geometry
C. $[\text{Ni}(\text{CN})_4]^{2-}$ and $[\text{Ni}(\text{CO})_4]$	r. Hybridization
D. $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{NiCl}_4]^{2-}$	s. Number of <i>d</i> -electrons in central metal ion

A	B	C	D
(a) q, r	q, s	p	p, s
(b) p, r	p, s	p, q, r	p, s
(c) q, r	q, p	p, q	p
(d) p, r	q, s	p, r, s	p

25. The standard reduction potential data at 25°C is given below.



Match E° of the redox pair in List I with the values given in List II and select the correct answer using the code given below.

List I	List II
P. $E^\circ(\text{Fe}^{3+}, \text{Fe})$	1. -0.18 V
Q. $E^\circ(4\text{H}_2\text{O} \rightarrow 4\text{H}^+ + 4\text{OH}^-)$	2. -0.4 V
R. $E^\circ(\text{Cu}^{2+} + \text{Cu} \rightarrow 2\text{Cu}^+)$	3. -0.04 V
S. $E^\circ(\text{Cr}^{3+}, \text{Cr}^{2+})$	4. -0.83 V

P	Q	R	S
(a) 4	1	2	3
(b) 2	3	4	1
(c) 1	2	3	4
(d) 3	4	1	2

26. The correct match between items of List-I and List-II is

List-I	List-II
(A) Phenelzine	(P) Pyrimidine
(B) Chloroxylenol	(Q) Furan
(C) Uracil	(R) Hydrazine
(D) Ranitidine	(S) Phenol

- (a) (A)-(S), (B)-(R), (C)-(P), (D)-(Q)
(b) (A)-(R), (B)-(S), (C)-(P), (D)-(Q)
(c) (A)-(S), (B)-(R), (C)-(Q), (D)-(P)
(d) (A)-(R), (B)-(S), (C)-(Q), (D)-(P)

27. All the compounds listed in Column I react with water. Match the result of the respective reactions with the appropriate options listed in Column II.

Column I	Column II
A. $(\text{CH}_3)_2\text{SiCl}_2$	p. Hydrogen halide formation
B. XeF_4	q. Redox reaction
C. Cl_2	r. Reacts with glass
D. VCl_5	s. Polymerization
	t. O_2 formation

A	B	C	D
(a) p, s	p, q, r, t	p, q	p
(b) q, r, s	p, q	r, s	q
(c) p, q	p, q, t	r, s	t
(d) q, r	p, q, t	p, q	r

INTEGER ANSWER TYPE

28. How many of the following alkenes on addition of HBr would give the same product in presence or absence of peroxide?

Propene, but-1-ene, but-2-ene, hex-3-ene,
2, 3-dimethylbut-2-ene, 1, 2-dimethylcyclohexene,
1,4-dimethyl-2-cyclohexene,
3,4-dimethylhex-3-ene, cyclohexene

29. MX_2 dissociates into M^{2+} and X^- ions in an aqueous solution, with a degree of dissociation (α) of 0.5. The ratio of the observed depression of freezing point of the aqueous solution to the value of the depression of freezing point in the absence of ionic dissociation is _____.

30. Galena (an ore) is partially oxidized by passing air through it at high temperature. After some time, the passage of air is stopped, but the heating is continued in a closed furnace such that the contents undergo self-reduction. The weight (in kg) of Pb produced per kg of O_2 consumed is _____.

(Atomic weights in g mol^{-1} : O = 16, S = 32, Pb = 207)

31. A crystalline solid of a pure substance has a face-centred cubic structure with a cell edge of 400 pm. If the density of the substance in the crystal is 8 g cm^{-3} , then the number of atoms present in 256 g of the crystal is $N \times 10^{24}$. The value of N is _____.

32. Among the triatomic molecules/ions, BeCl_2 , N_3^- , N_2O , NO_2^+ , O_3 , SCl_2 , ICl_2^- , I_3^- and XeF_2 , the total number of linear molecule(s)/ion(s) where the hybridization of the central atom does not have contribution from the *d*-orbital(s) is _____.

[Atomic number : S = 16, Cl = 17, I = 53 and Xe = 54]

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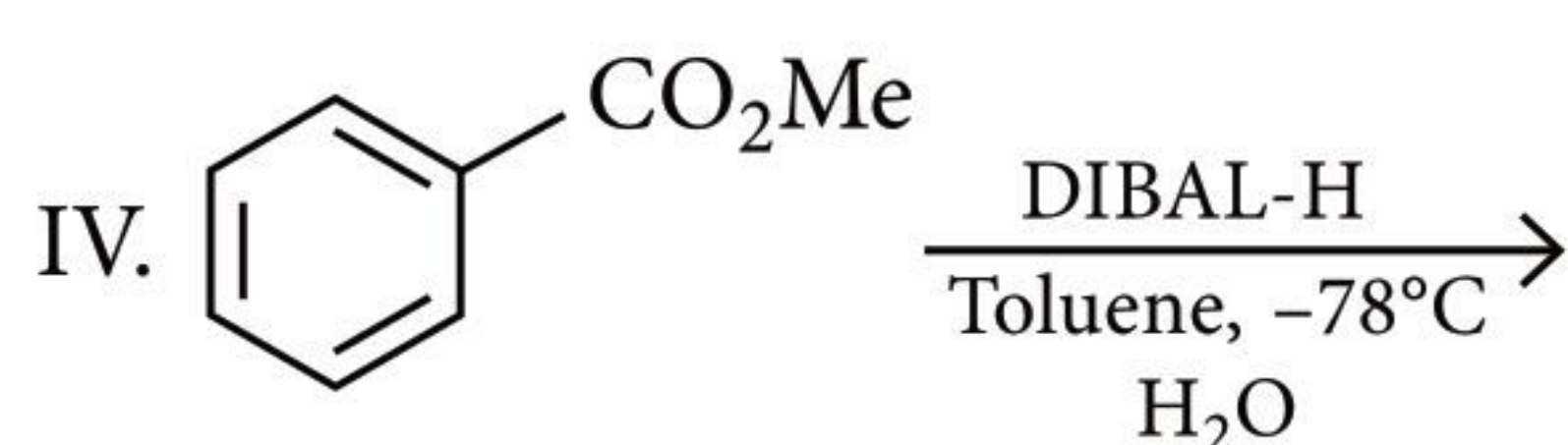
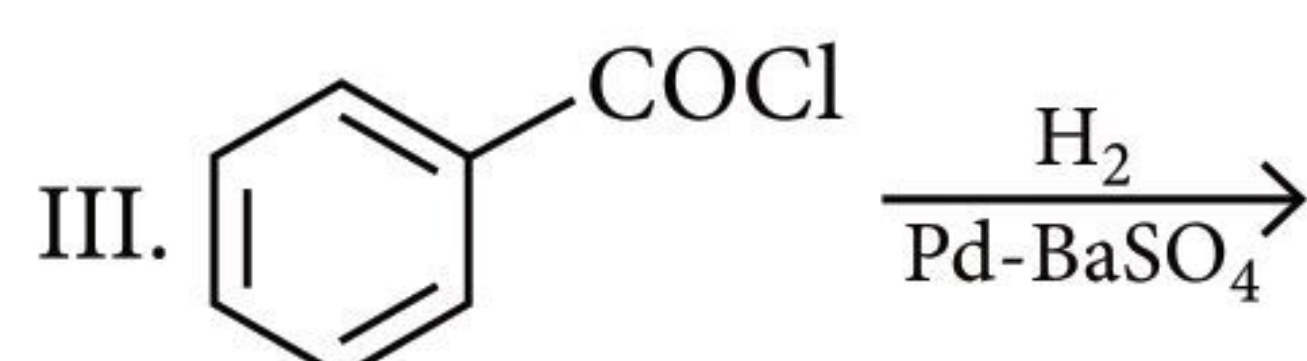
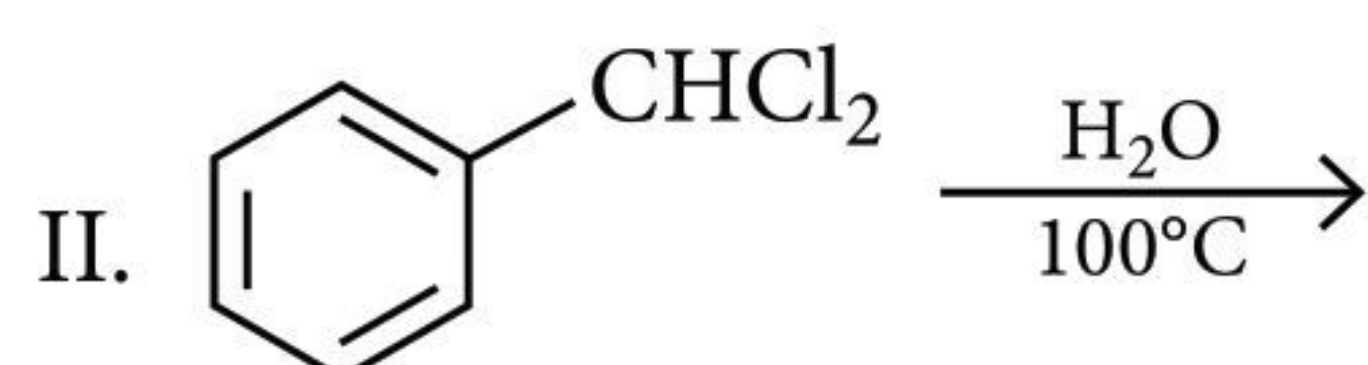
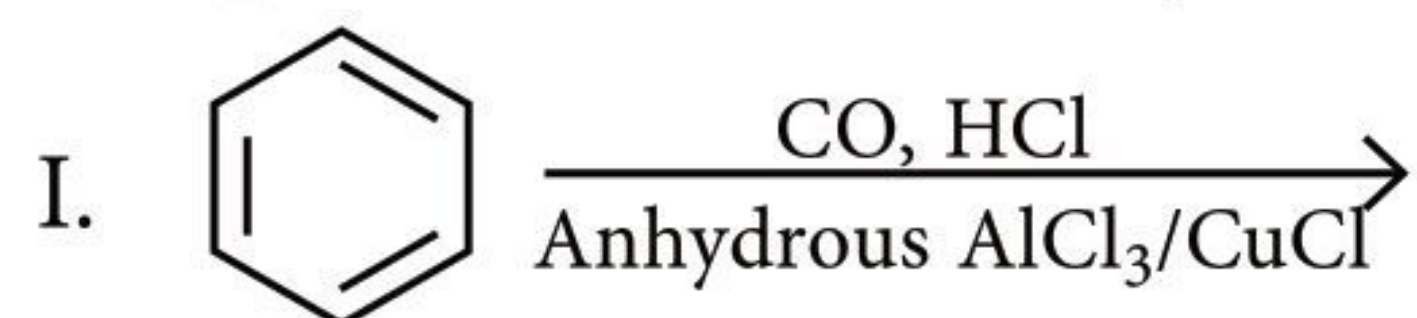
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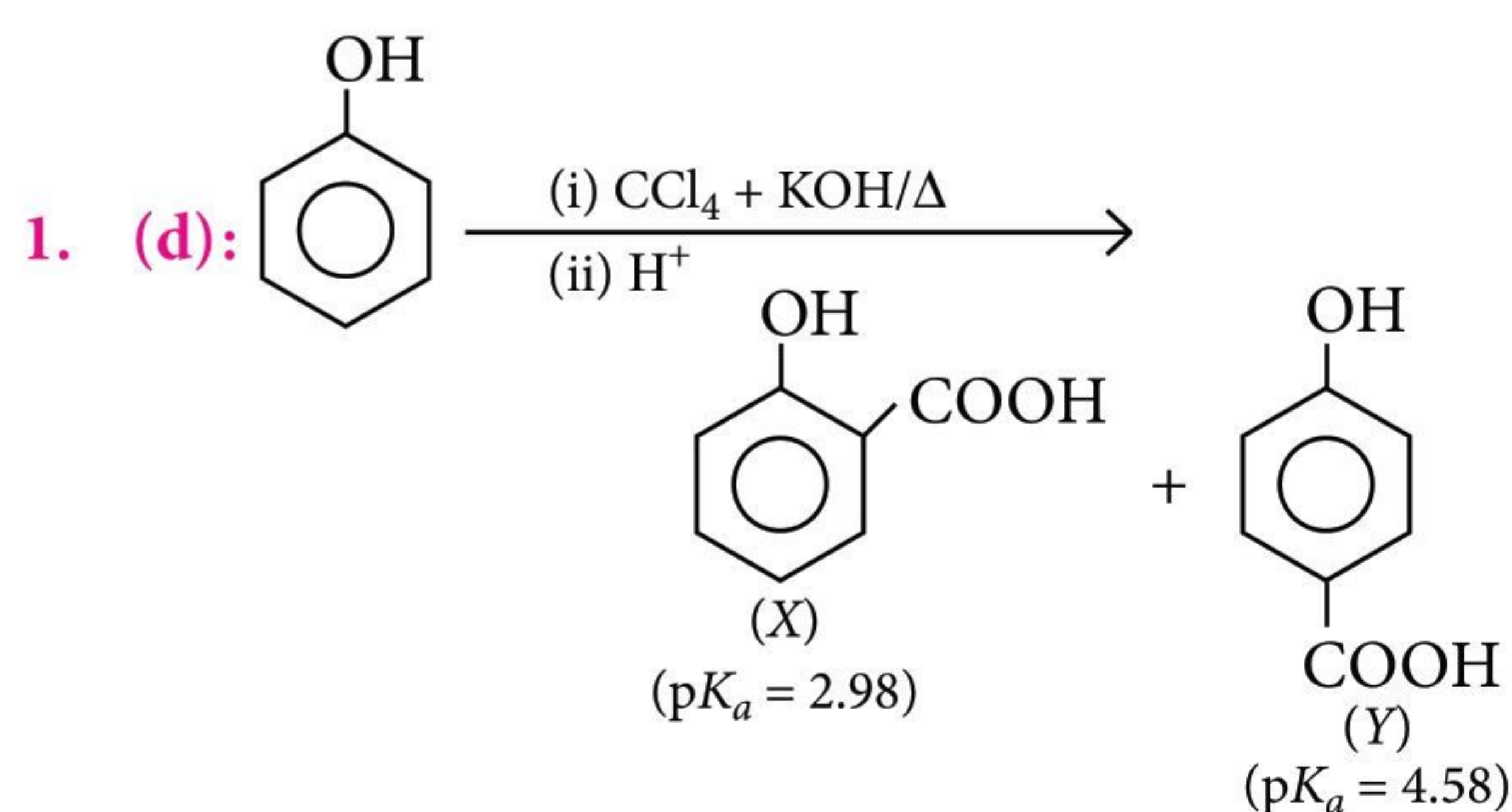
33. Reaction $A + B \longrightarrow C + D$ follows, rate law, $r = k[A]^{1/2} [B]^{1/2}$ starting with 1 M of A and B each. What is the time taken for concentration of A to become 0.1 M? (Given $k = 2.303 \times 10^{-2} \text{ sec}^{-1}$) _____.

34. Among the following, the number of reaction(s) that produce(s) benzaldehyde is _____.



35. For the octahedral complexes of Fe^{3+} in SCN^- (thiocyanato-S) and in CN^- ligand environments, the difference between the spin-only magnetic moments in Bohr magnetons (when approximated to the nearest integer) is _____.
[Atomic number of Fe = 26]

SOLUTIONS



Acidic strength : $X > Y$

(Carboxylate anion stabilized by H-bonding)

Solubility in H_2O : $Y > X$

(Intermolecular H-bonding in Y)

Volatility : $X > Y$ (Intramolecular H-bonding in X)

M.Pt. : $Y > X$ (More symmetrical structure of Y)

2. (c) : From given information,

$$Q = \tan 75^\circ = 3.73 = \frac{\text{conc. of iso-butane}}{\text{conc. of n-butane}} > K_c$$

So, reaction will go in backward direction.

3. (c) : $E_1 = -2.17 \times 10^{-11} \text{ ergs per atom}$
 $= -2.17 \times 10^{-18} \text{ J atom}^{-1}$

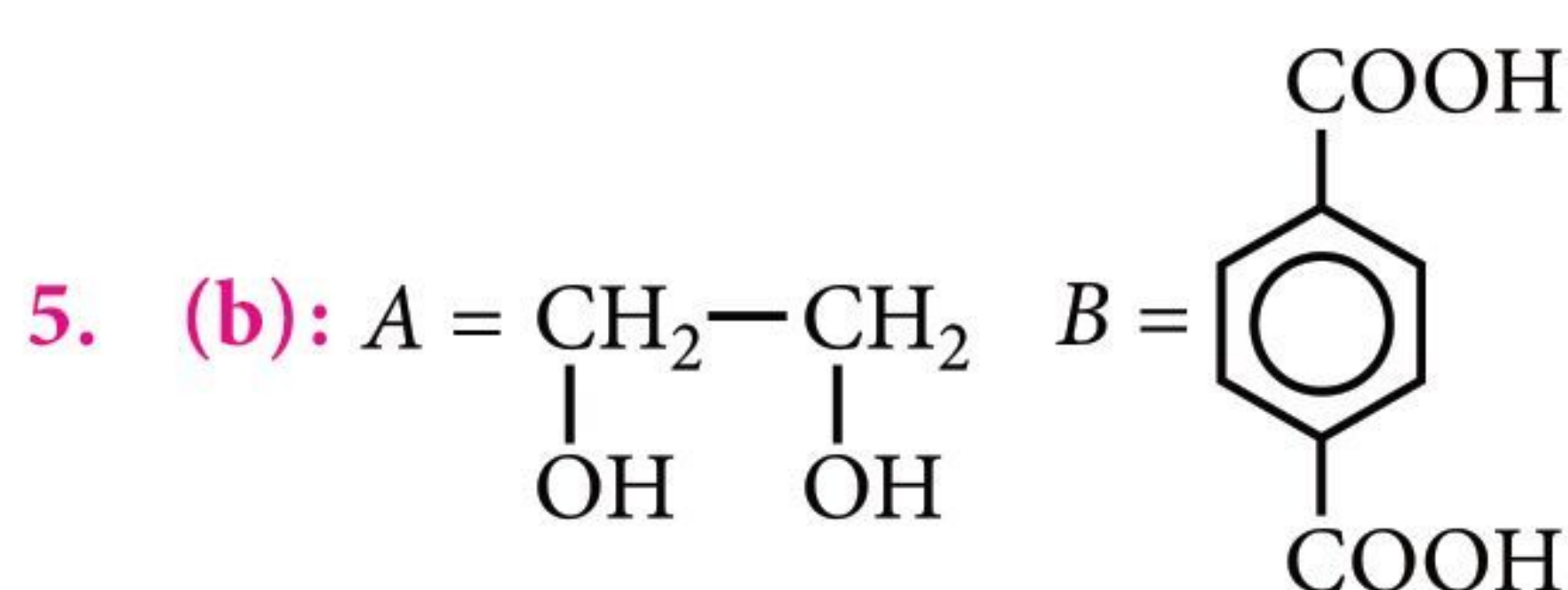
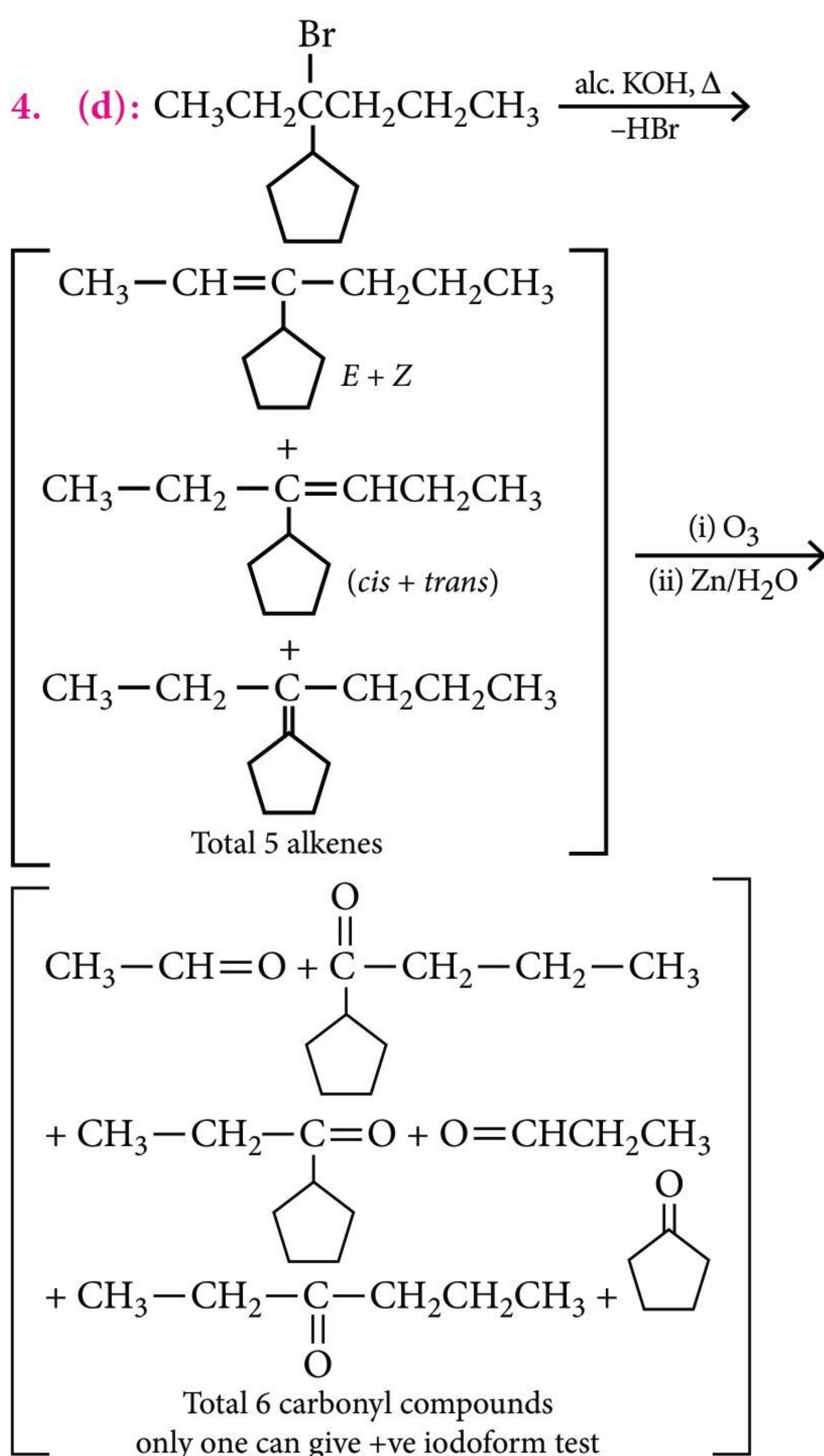
$$E_n = \frac{E}{n^2} \Rightarrow E_3 = -\frac{2.17 \times 10^{-18}}{3^2}$$

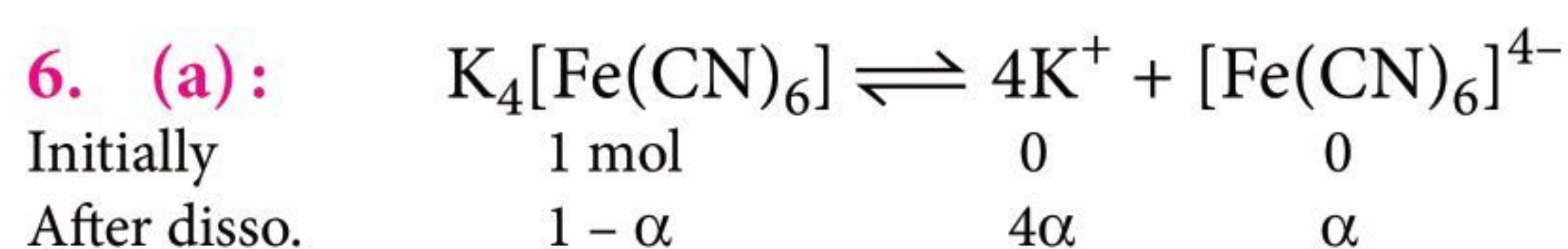
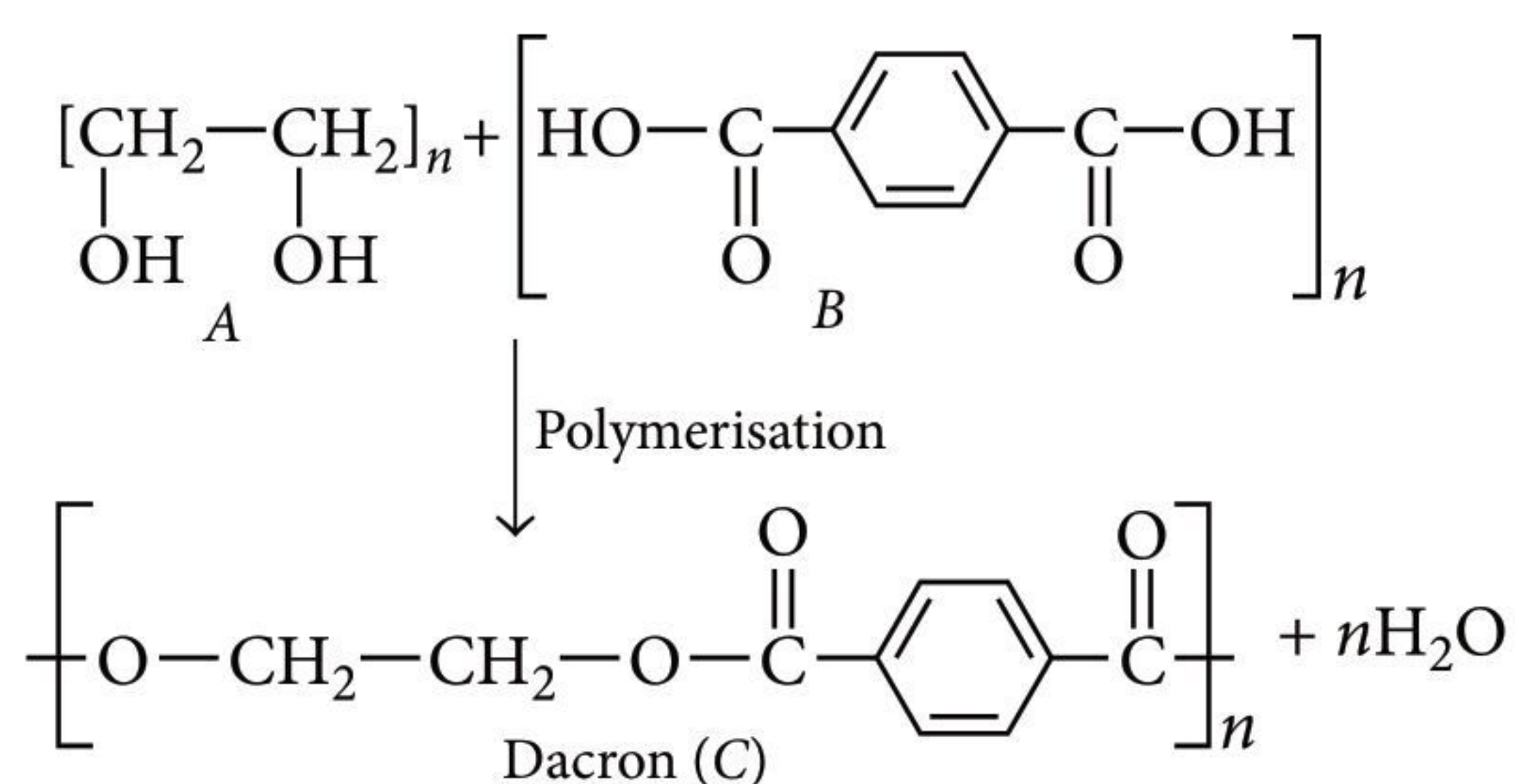
$$\Delta E = E_3 - E_1 = -\frac{2.17 \times 10^{-18}}{9} - (-2.17 \times 10^{-18})$$

$$= 1.93 \times 10^{-18} \text{ J atom}^{-1}$$

$$\text{Now, } \Delta E = \frac{hc}{\lambda}$$

$$\lambda = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{1.93 \times 10^{-18}} = 10.26 \times 10^{-8} \text{ m} = 1026 \text{ \AA}$$





Total moles after dissociation = $1 + 4\alpha$

As the solute is 50% dissociated therefore

$$i = 1 + (n - 1)\alpha = 1 + 4 \times \frac{1}{2} = 3$$

$$m = \frac{M \times 1000}{d \times 1000 - MM_2} = \frac{0.1 \times 1000}{1000 \times 1.2 - 0.1 \times 368}$$

$$\begin{aligned}
 \frac{p^\circ - p_s}{p_s} &= \frac{i \times m \times M_1}{1000} \\
 &= \left(\frac{3 \times 0.1 \times 1000}{1000 \times 1.2 - 0.1 \times 368} \right) \times \frac{18}{1000}
 \end{aligned}$$

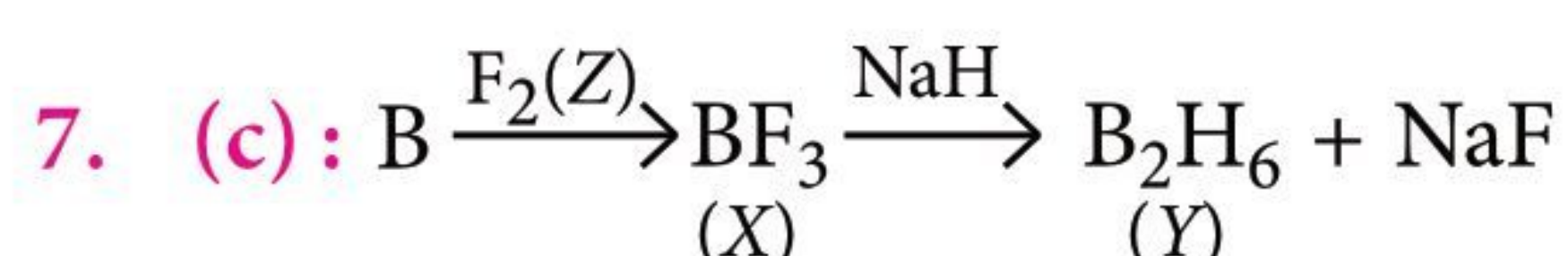
$$\frac{p^\circ}{p_s} = 1 + 4.64 \times 10^{-3};$$

$$\frac{p^\circ}{p_s} = 1.00464$$

$$\Rightarrow \frac{25}{1.00464} = p_s$$

or $p_s = 24.88$ mm of Hg

$$\Delta p = 25 - 24.88 = 0.12 \text{ mm of Hg}$$



8. (d): (I) Adjacent O atom carrying lone pair of electrons and hyperconjugation effect of two $-\text{CH}_3$ groups provides stabilisation to the carbocation.

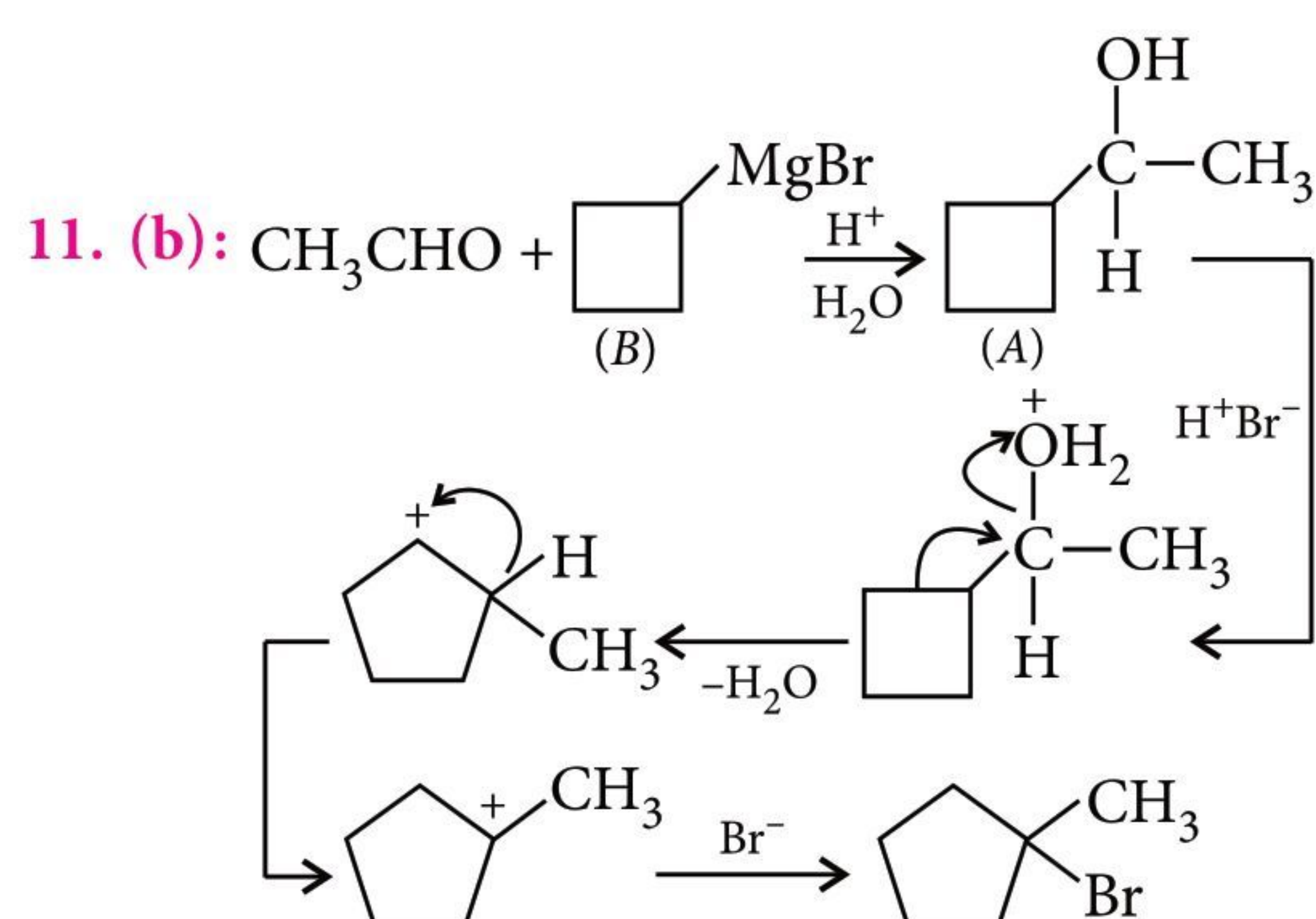
(II) is a simple 2° carbocation

(III) Adjacent O atom carrying lone pair of electrons and hyperconjugation effect of one $-\text{CH}_3$ group.

(IV) is a simple 1° carbocation.

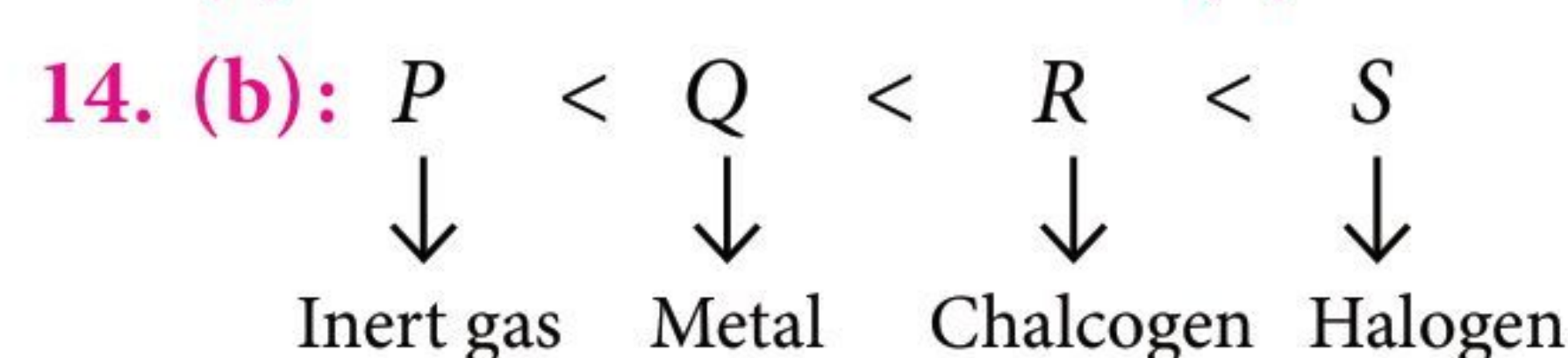
9. (a)

10. (a): Structure (X) is of sucrose, a disaccharide which is a non-reducing sugar. Thus, it does not react with Tollens' reagent whereas (Y) is maltose, a reducing sugar.



12. (c)

13. (a)



15. (a): According to Freundlich adsorption isotherm,

$$\frac{x}{m} = kC^{1/n} \quad \dots(i)$$

5% vinegar (acetic acid solution) means 5 g of acetic acid is present in 100 mL of the solution.

Molar mass of acetic acid (CH_3COOH) = 60 g mol^{-1}

$$\therefore 5 \text{ g of acetic acid} = \frac{5}{60} \text{ mol}$$

\therefore 1000 mL of the solution will contain acetic acid

$$= \frac{5}{60} \times \frac{1}{100} \times 1000 = 0.833 \text{ mol L}^{-1}$$

i.e., Concentration of the solution (C) = 0.833 mol L^{-1}

$$\frac{x}{m} = 0.160 \times (0.833)^{1/2.32}$$

$$\begin{aligned}
 \therefore \log \frac{x}{m} &= \log(0.160) + \frac{1}{2.32} \log(0.833) \\
 &= -0.7959 + 0.431(-0.0794) = -0.8301
 \end{aligned}$$

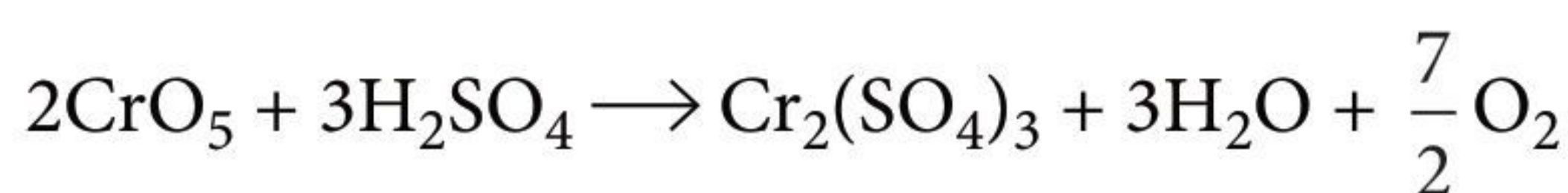
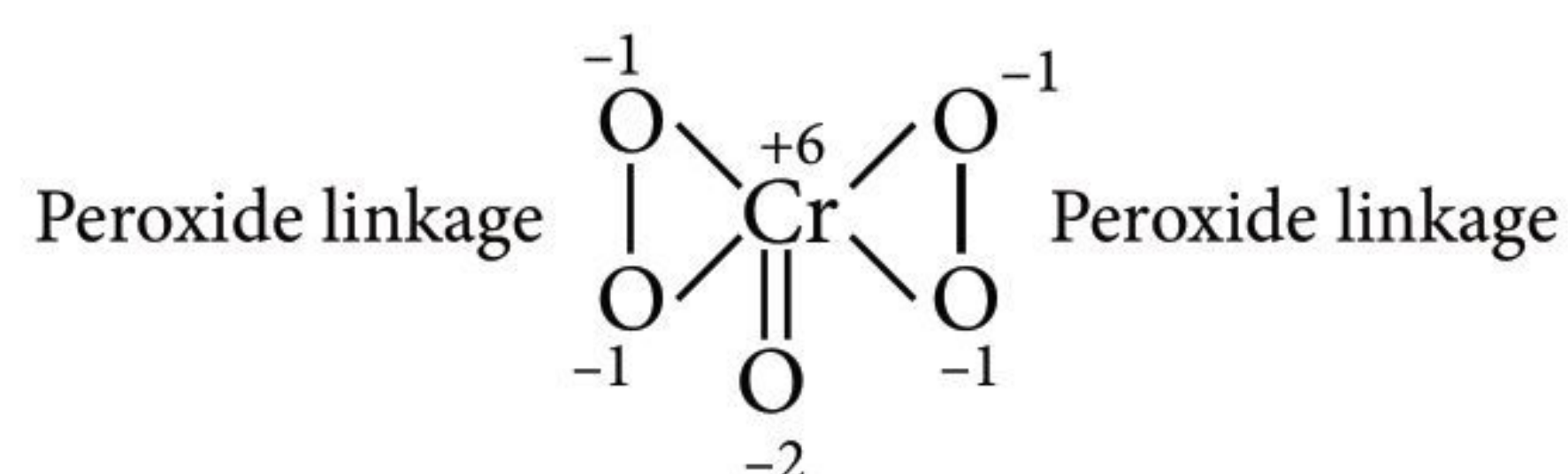
$$\therefore \frac{x}{m} = \text{Antilog}(-0.8301) = 0.1478 \text{ g}$$

$$\begin{aligned}
 \therefore \text{Amount adsorbed by 1 kg (1000 g) of charcoal} \\
 = 147.8 \text{ g}
 \end{aligned}$$

MONTHLY TEST DRIVE CLASS XII ANSWER KEY

1. (b)	2. (c)	3. (d)	4. (d)	5. (b)
6. (b)	7. (d)	8. (c)	9. (d)	10. (d)
11. (c)	12. (c)	13. (d)	14. (a)	15. (d)
16. (a)	17. (b)	18. (a)	19. (d)	20. (a,c,d)
21. (b,d)	22. (b,c)	23. (a,b,c)	24. (3)	25. (3)
26. (1)	27. (c)	28. (c)	29. (c)	30. (b)

16. (a,d) : The oxidation state of Cr in CrO_5 is +6.



\therefore One mole of CrO_5 will liberate $7/4$ mole of O_2 .

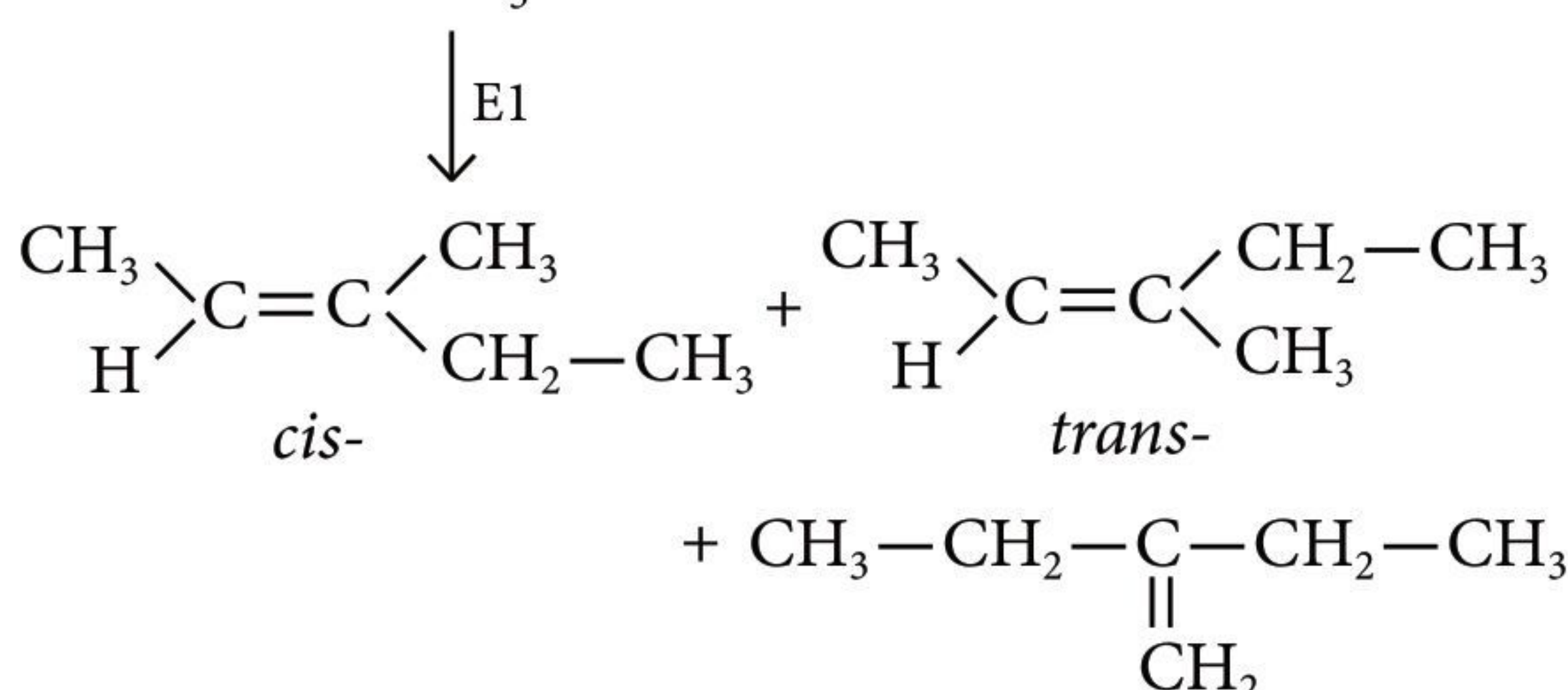
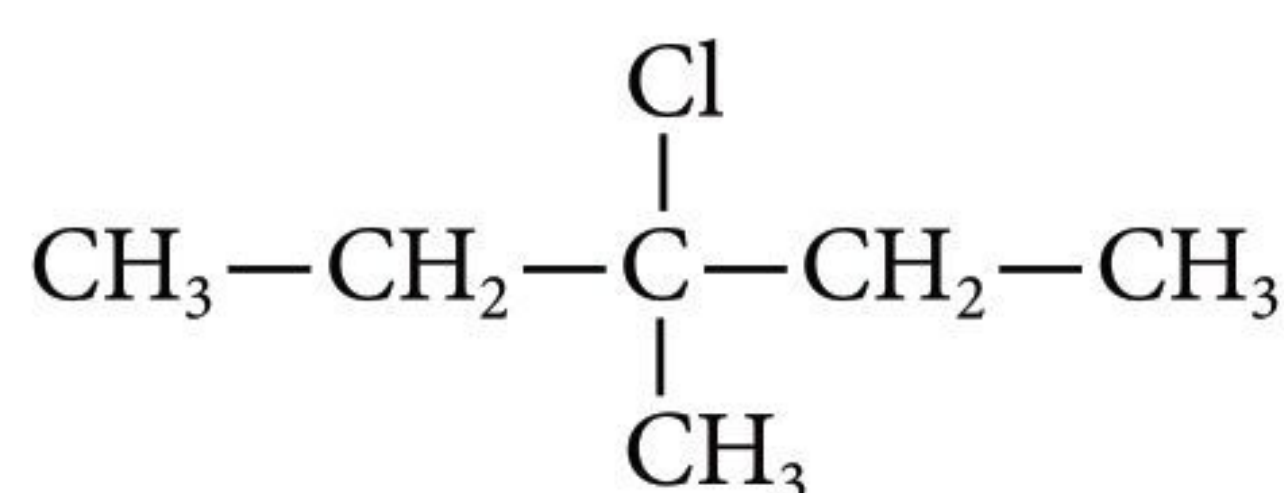
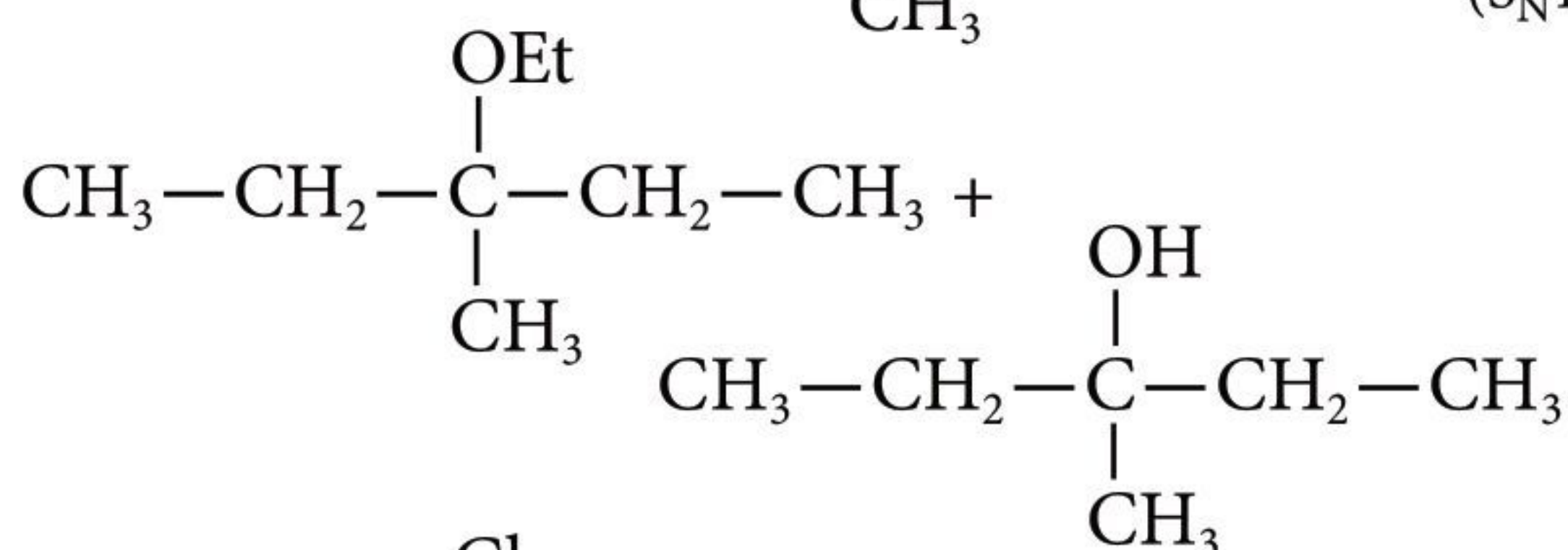
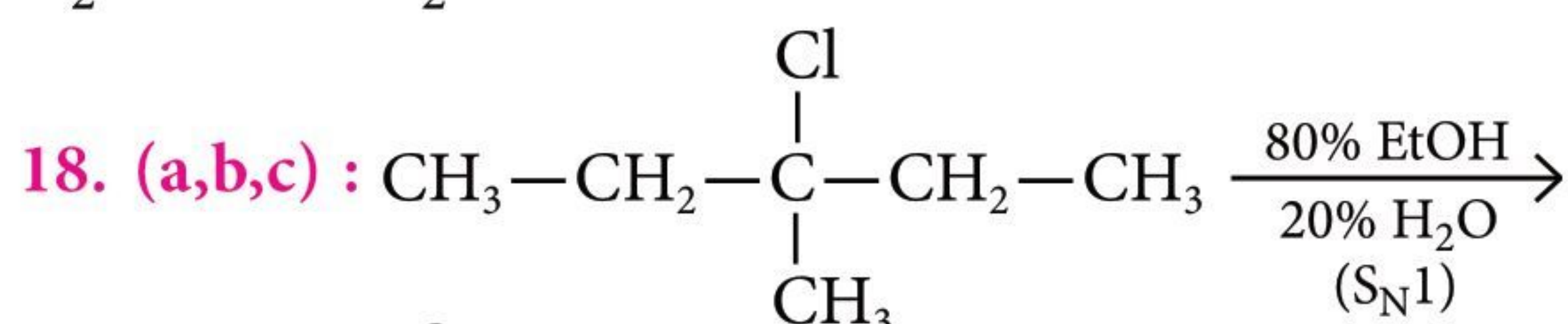
17. (c,d) : Bond strength of $\text{CO} < \text{CO}^+$.

Bond length $\propto 1/\text{bond order}$.

Unpaired electron : $\text{O}_2 = 2$, $\text{NO} = 1$ and $\text{CO} = 0$

Number of ABMO electrons : $\text{O}_2 = 6$,

$\text{N}_2^- = 5$ and $\text{Be}_2 = 4$.



19. (a,c,d) : (a) $T_1 = T_2$ as the process is isothermal.

Hence, (a) is correct.

(b) $T_3 < T_1$ because cooling takes place on adiabatic expansion. Hence (b) is incorrect.

(c) $w_{\text{isothermal}} > w_{\text{adiabatic}}$ because area under the isothermal curve is greater than under the adiabatic curve. Hence (c) is correct.

(d) $\Delta U_{\text{adiabatic}} = -ve$ because when adiabatic expansion occurs, internal energy decreases. Thus, $\Delta U_{\text{isothermal}} > \Delta U_{\text{adiabatic}}$. Hence (d) is correct.

20. (b) : $\text{X}_{2(g)} \rightleftharpoons 2\text{X}_{(g)}$

At $t = 0$, $\quad 1 \quad \quad \quad 0$

At eq. $\quad 1 - \frac{\beta_{eq}}{2} \quad \quad \quad \beta_{eq}$

$$K_p = \frac{(p_X)^2}{(p_{X_2})}$$

$$p_X = \left(\frac{\beta_{eq}}{1 - \frac{\beta_{eq}}{2} + \beta_{eq}} \right) p_{\text{total}} = \left(\frac{\beta_{eq}}{1 + \frac{\beta_{eq}}{2}} \right) p_{\text{total}}$$

$$p_{X_2} = \left(\frac{1 - \frac{\beta_{eq}}{2}}{1 + \frac{\beta_{eq}}{2}} \right) p_{\text{total}}$$

$$K_p = \frac{\left[\left(\frac{\beta_{eq}}{1 + \frac{\beta_{eq}}{2}} \right) p_{\text{total}} \right]^2}{\left(\frac{1 - \frac{\beta_{eq}}{2}}{1 + \frac{\beta_{eq}}{2}} \right) p_{\text{total}}} = \left(\frac{\beta_{eq}^2}{1 - \frac{\beta_{eq}^2}{4}} \right) p_{\text{total}}$$

$$= \left(\frac{4\beta_{eq}^2}{4 - \beta_{eq}^2} \right) p_{\text{total}} = \left(\frac{4\beta_{eq}^2}{4 - \beta_{eq}^2} \right) \times 2 = \frac{8\beta_{eq}^2}{4 - \beta_{eq}^2}$$

21. (c) : (a) If the pressure on the system is decreased, the equilibrium will shift in the direction in which pressure increases *i.e.*, increase in no. of moles takes place *i.e.*, in forward direction.

(b) At the start of the reaction, $Q < K$ thus, the reaction will proceed in the forward direction *i.e.*, reaction is spontaneous.

(c) If $\beta_{eq} = 0.7$ then, $K_p = \frac{8 \times (0.7)^2}{4 - (0.7)^2} > 1$

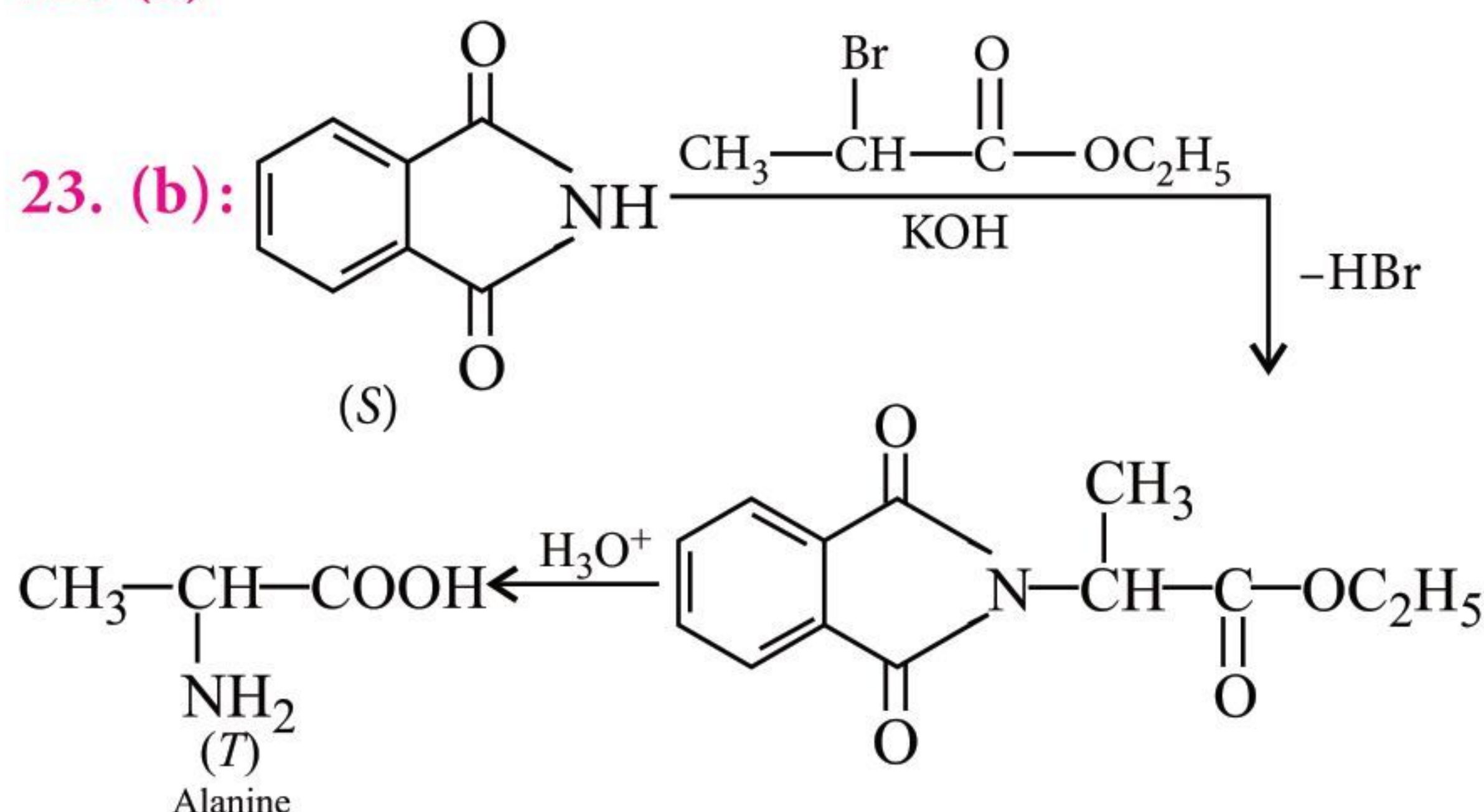
EXAM ALERT 2022

Exam	Date
JEE Main	Session 1: 23 rd to 29 th June Session 2: 21 st to 30 th July
NEET	17 th July
BITSAT	Session-I: 2 nd to 9 th July Session-II: 3 rd to 7 th August
KEAM	4 th July
VITEEE	30 th June to 6 th July
JEE Advanced	28 th August

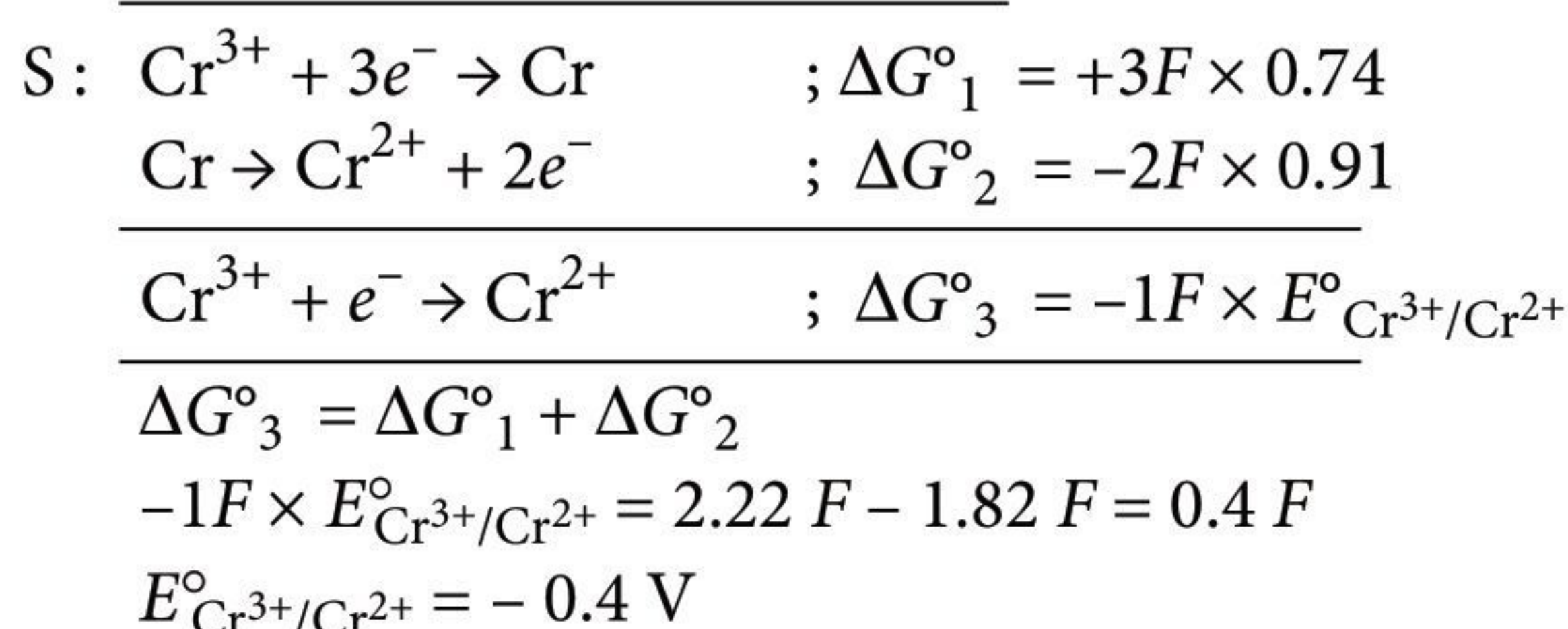
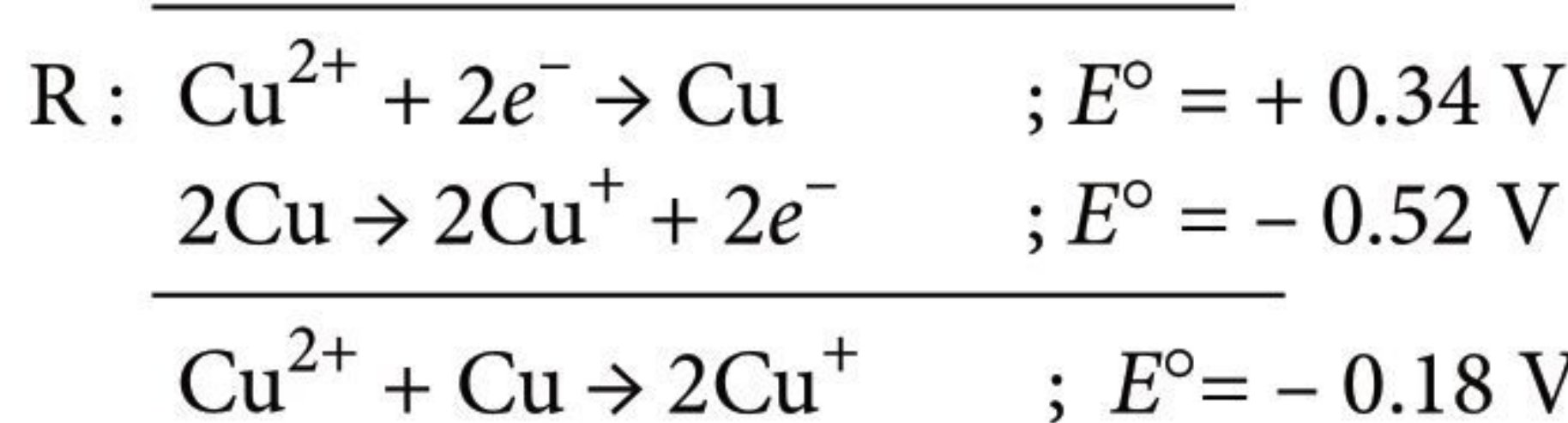
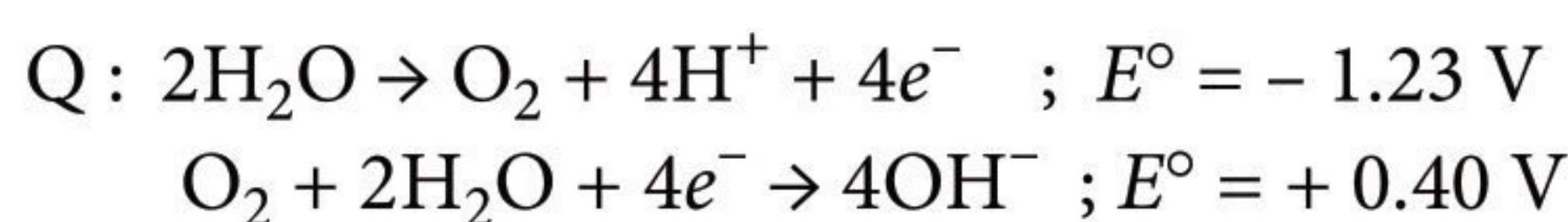
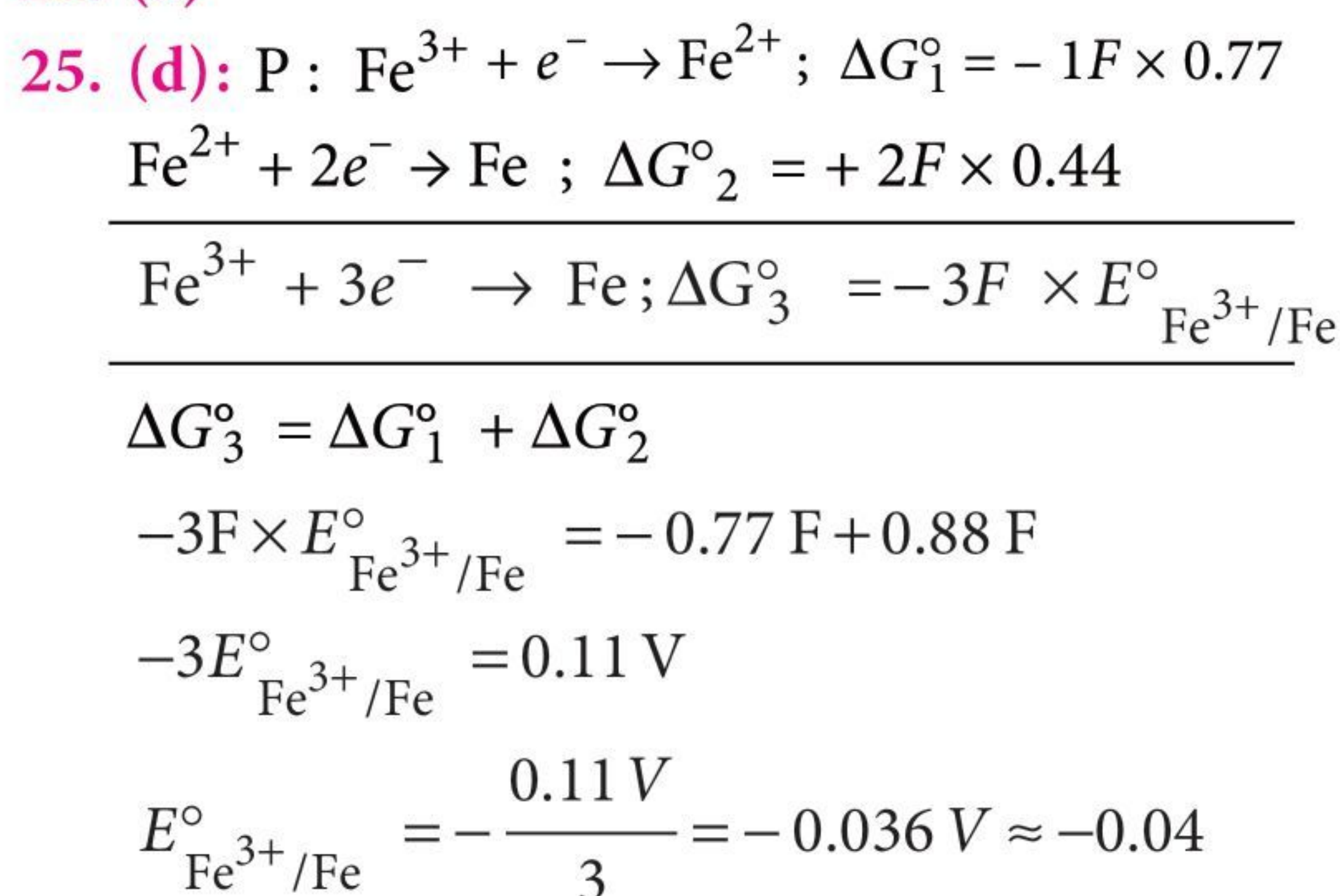
$\Delta G^\circ = -RT \ln K_p$ so, $\Delta G^\circ = -ve$ but given $\Delta G^\circ = +ve$ so, K_p should be less than 1 hence, $\beta_{eq} \neq 0.7$.

(d) $K_p = K_c (RT)^{\Delta n}$
 $K_c < K_p$ ($\because RT > 1$)
 If $K_p < 1$ then $K_c < 1$

22. (a)



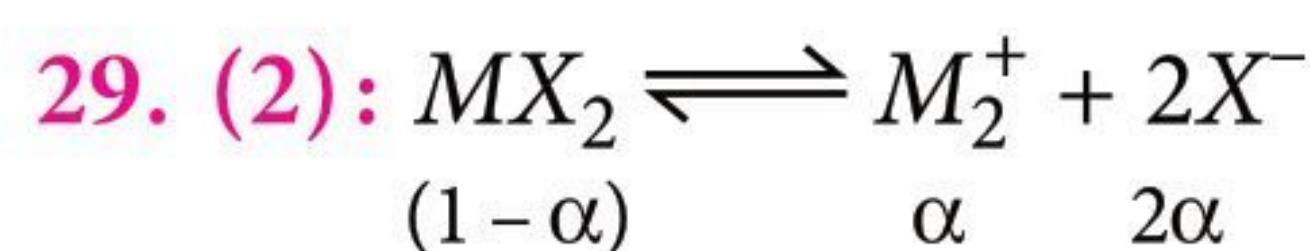
24. (a)



26. (b)

27. (a)

28. (7): Only symmetrical alkenes give the same product in presence or absence of peroxides. Here, only unsymmetrical alkenes are propene and but-1-ene while all the remaining seven are symmetrical alkenes.



$$i = 1 - \alpha + \alpha + 2\alpha$$

$$i = 1 + 2\alpha$$

$$(\because \alpha = 0.5)$$

$$i = 1 + 2 \times 0.5 = 2$$



3 moles of O_2 produce 3 moles of lead.

96 kg of oxygen produce 621 kg of lead.

$$1 \text{ kg of oxygen produce } \frac{621}{96} = 6.468 = 6.47 \text{ kg}$$

31. (2)

32. (4): BeCl_2 , N_3^- , N_2O and NO_2^+ possess sp hybridisation and are linear.



$$\begin{array}{ccccccc} t=0 & 1 & 1 & & & & \\ t & 1-x & 1-x & x & x & & \end{array}$$

$$r = k[A]^{1/2}[B]^{1/2}$$

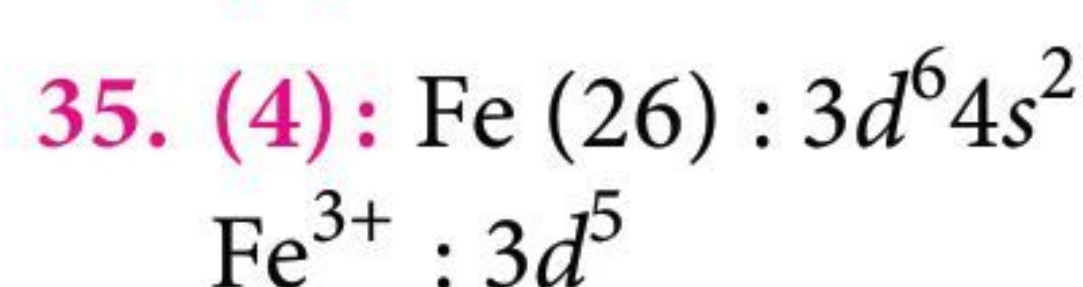
$$\frac{dx}{dt} = k(1-x)^{1/2}(1-x)^{1/2}$$

$$\frac{dx}{dt} = k(1-x) \Rightarrow t = \frac{1}{k} \ln \left(\frac{1}{1-x} \right)$$

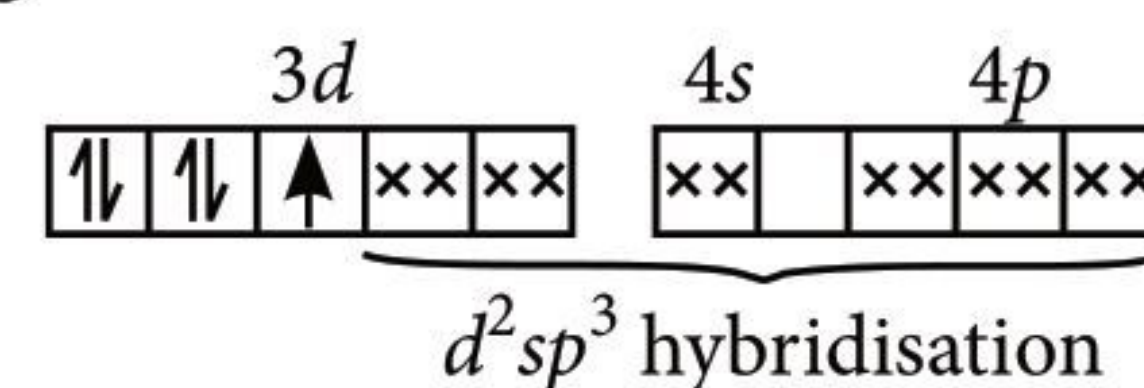
$$t = \frac{2.303}{2.303 \times 10^{-2}} \log \left(\frac{1}{0.1} \right) = 100 \text{ sec}$$

All the given reactions produce benzaldehyde.

34. (4)

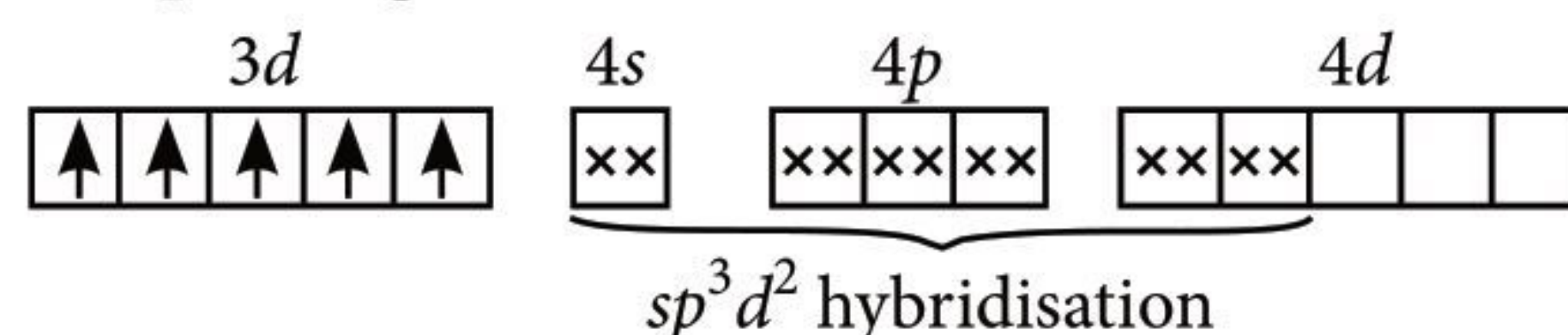


In $[\text{Fe}(\text{CN})_6]^{3-}$, CN^- is a strong field ligand which causes pairing of electrons.



$$\mu = \sqrt{n(n+2)} = \sqrt{1(1+2)} = \sqrt{3} = 1.732 \text{ BM}$$

In $[\text{Fe}(\text{SCN})_6]^{3-}$, SCN^- being a weak field ligand does not cause pairing of electrons.



$$\mu = \sqrt{n(n+2)} = \sqrt{5(5+2)} = \sqrt{35} = 5.916 \text{ BM}$$

$$\text{Difference} = 5.916 - 1.732 = 4.184 \approx 4 \text{ BM}$$



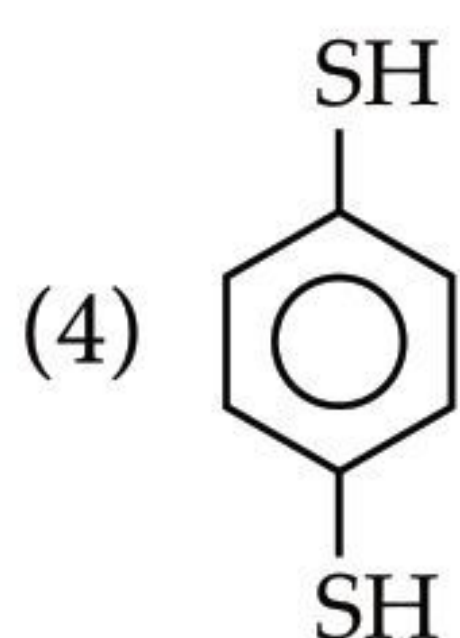
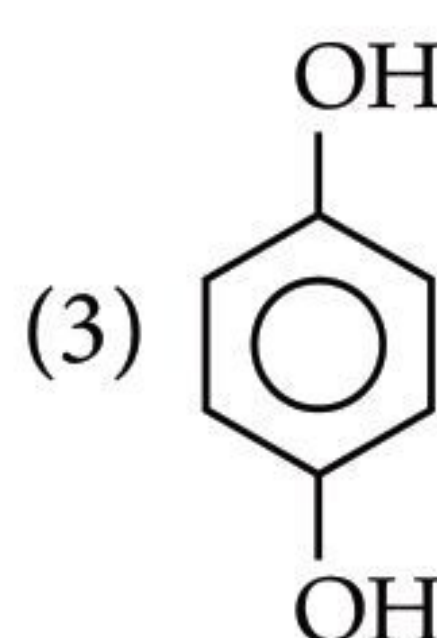
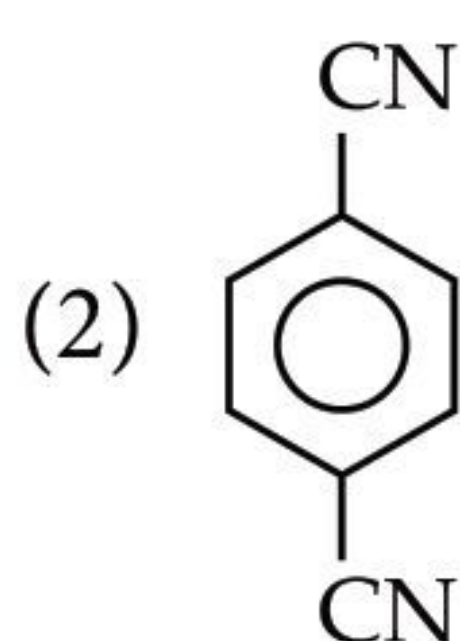
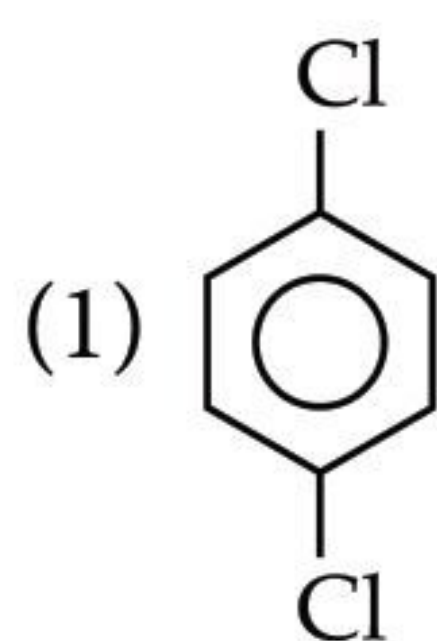
GET SET GO for JEE



with exclusive and brain storming MCQs

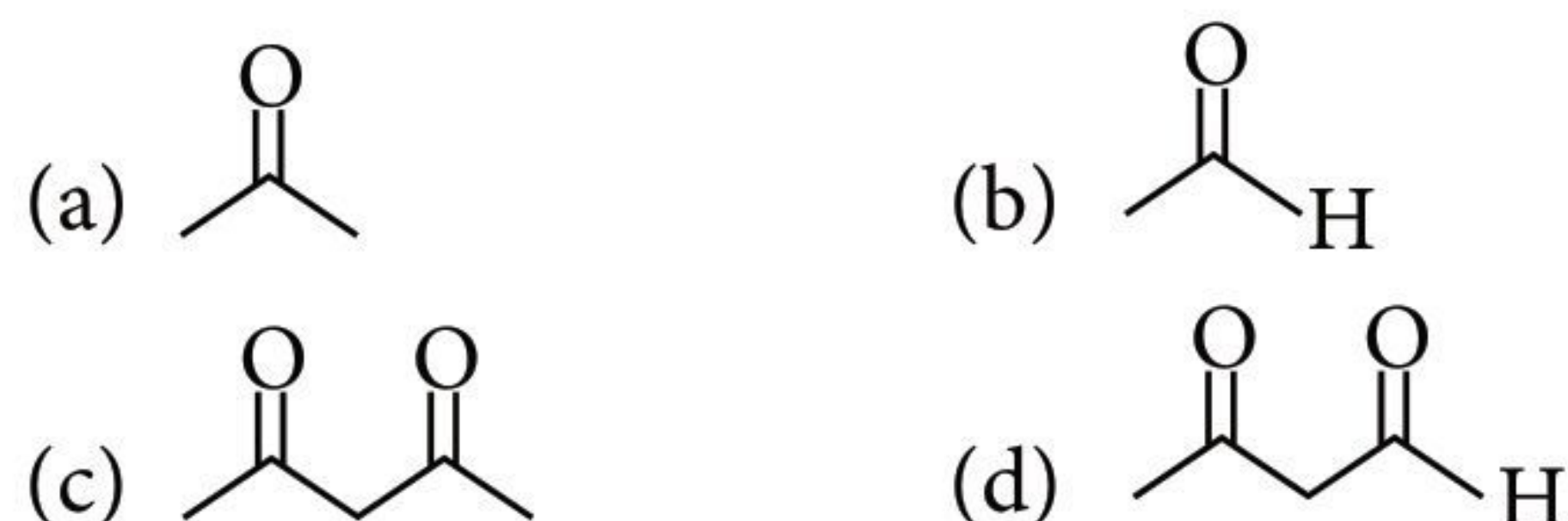
Practicing these MCQs help to strengthen your concepts and give you extra edge in your JEE preparation

1. For which of the following molecules significant $\mu \neq 0$?



- (a) (3) and (4) (b) Only (1)
(c) (1) and (2) (d) Only (3)
2. pK_a of a weak acid (HA) and pK_b of a weak base (BOH) are 3.2 and 3.4 respectively. The pH of their salt (AB) solution is
(a) 7.0 (b) 1.0
(c) 7.2 (d) 6.9
3. For the reaction :
 $I^- + ClO_3^- + H_2SO_4 \longrightarrow Cl^- + HSO_4^- + I_2$
The incorrect statement with respect to the balanced equation is
(a) stoichiometric coefficient of HSO_4^- is 6
(b) iodide is oxidized
(c) sulphur is reduced
(d) H_2O is one of the products.
4. The correct statement is
(a) BI_3 is the weakest Lewis acid among the boron halides
(b) there is minimum $p\pi-p\pi$ back bonding in BF_3
(c) BF_3 is the strongest Lewis acid among the other boron halides
(d) there is maximum $p\pi-p\pi$ back bonding in BF_3 .
5. The hyperconjugative stabilities of *tert*-butyl cation and but-2-ene, respectively, are due to
(a) $\sigma \rightarrow \pi$ (empty) and $\sigma \rightarrow \pi^*$ electron delocalisations
(b) $\sigma \rightarrow \sigma^*$ and $\sigma \rightarrow \pi$ electron delocalisations
(c) $\sigma \rightarrow \pi$ (filled) and $\sigma \rightarrow \pi$ electron delocalisations
(d) π (filled) $\rightarrow \sigma^*$ and $\sigma \rightarrow \pi^*$ electron delocalisations.
6. What will be the correct nucleophilicity order in protic or aprotic solvents?
(a) $SH^- > CN^- > I^- > OH^-$ in aprotic solvent
(b) $CN^- > SH^- > OH^- > I^-$ in protic solvent
(c) $SH^- > CN^- > I^- > OH^-$ in protic solvent
(d) $I^- > Br^- > Cl^- > F^-$ in aprotic solvent

7. The maximum enol content is in



8. One mole of magnesium nitride on reaction with an excess of water gives

- (a) 1 mole of ammonia
 (b) 1 mole of nitric acid
 (c) 2 moles of nitric acid
 (d) 2 moles of ammonia.

9. The most stable +2 oxidation state is exhibited by

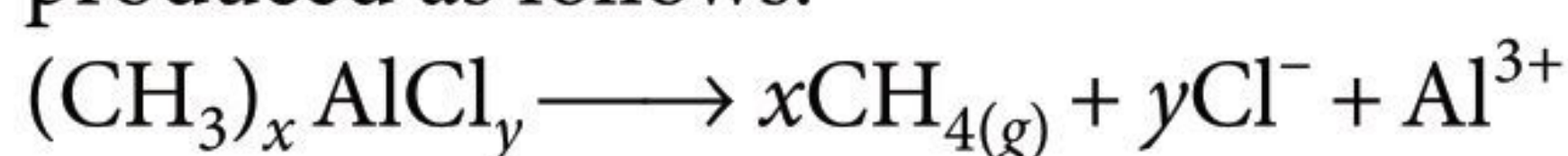
- (a) Ge (b) Sn
 (c) Pb (d) Si

10. Hex-2-yne gives *trans*-hex-2-ene on treatment with

- (I) Li/NH₃ (II) Pd/BaSO₄
 (III) LiAlH₄ (IV) Pt/H₂
 (a) I only (b) I and II
 (c) IV only (d) I and III

NUMERICAL PROBLEMS

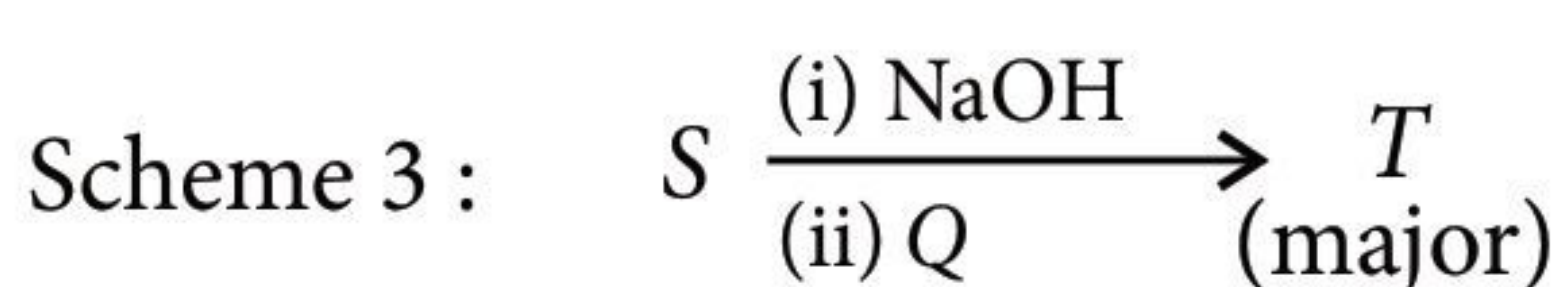
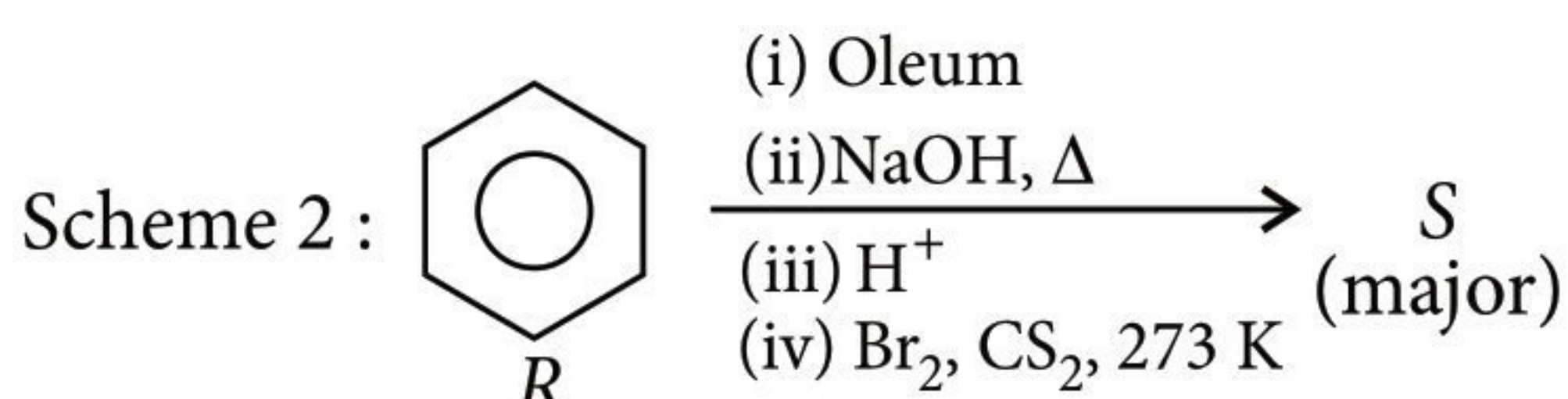
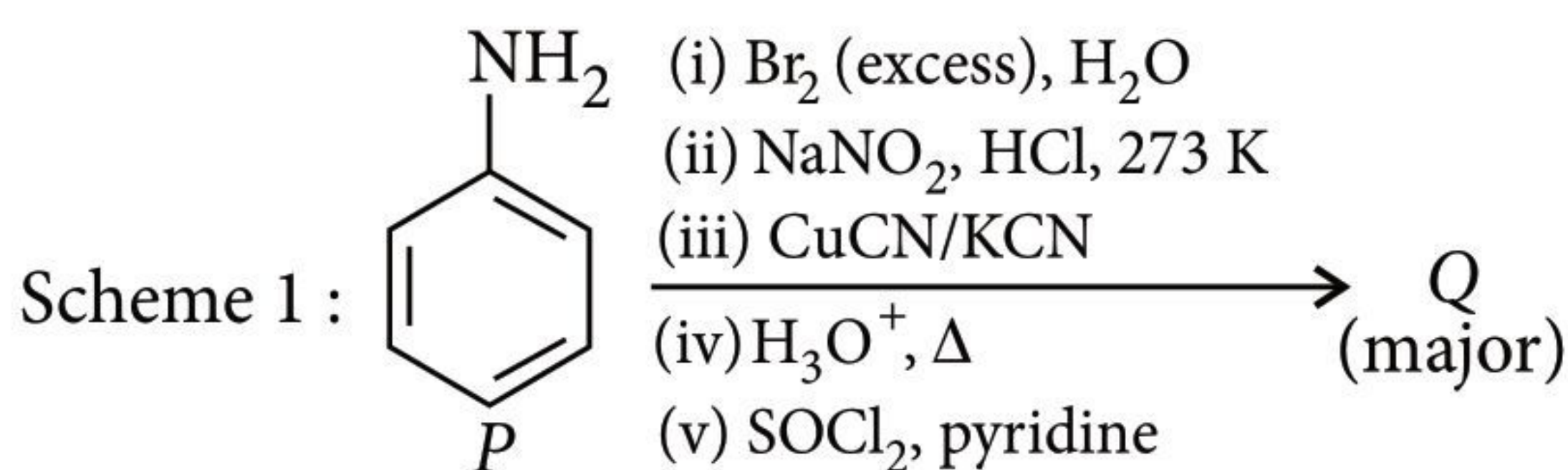
11. When (CH₃)_xAlCl_y is ignited CH₄, Cl⁻ and Al³⁺ are produced as follows:



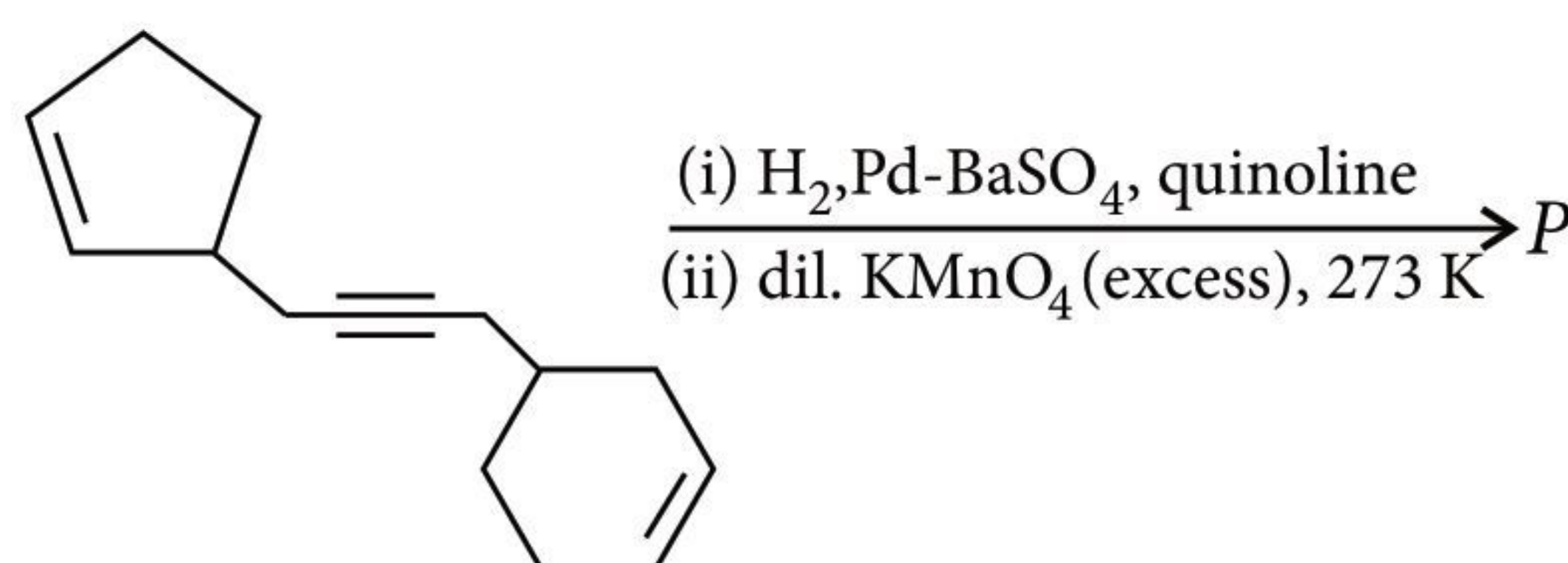
The ignition of 0.643 g of (CH₃)_xAlCl_y yields 1.39 × 10⁻² moles of CH_{4(g)}. The resulting solution on reaction with excess AgNO₃ yields 6.64 × 10⁻³ moles of AgCl_(s).

The minimum molecular mass of (CH₃)_xAlCl_y is _____.

12. Schemes 1 and 2 describe the conversion of *P* to *Q* and *R* to *S*, respectively. Scheme 3 describes the synthesis of *T* from *Q* and *S*. The total number of Br atoms in a molecule of *T* is _____.



13. Total number of hydroxyl groups present in a molecule of the major product *P* is _____.

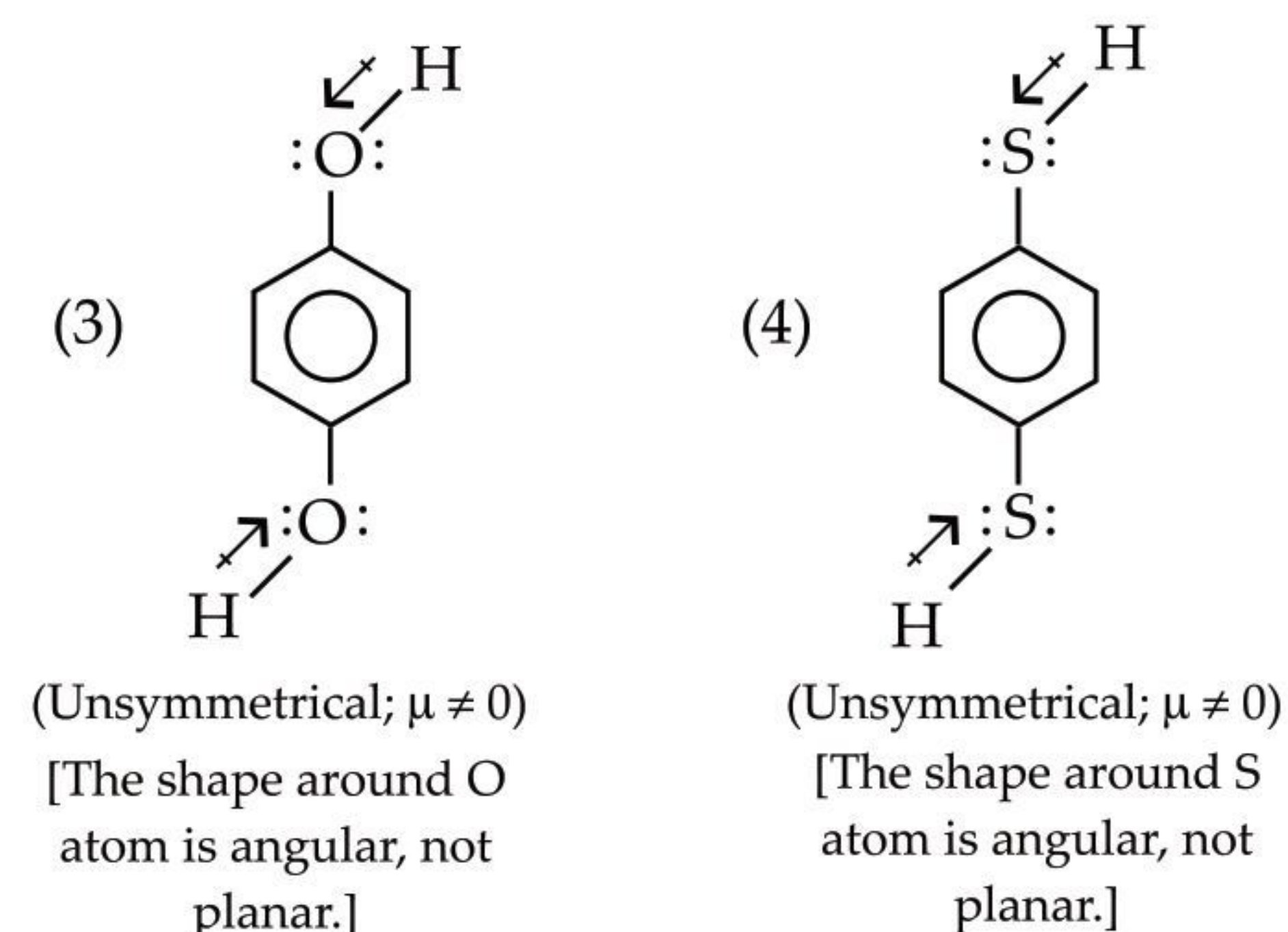
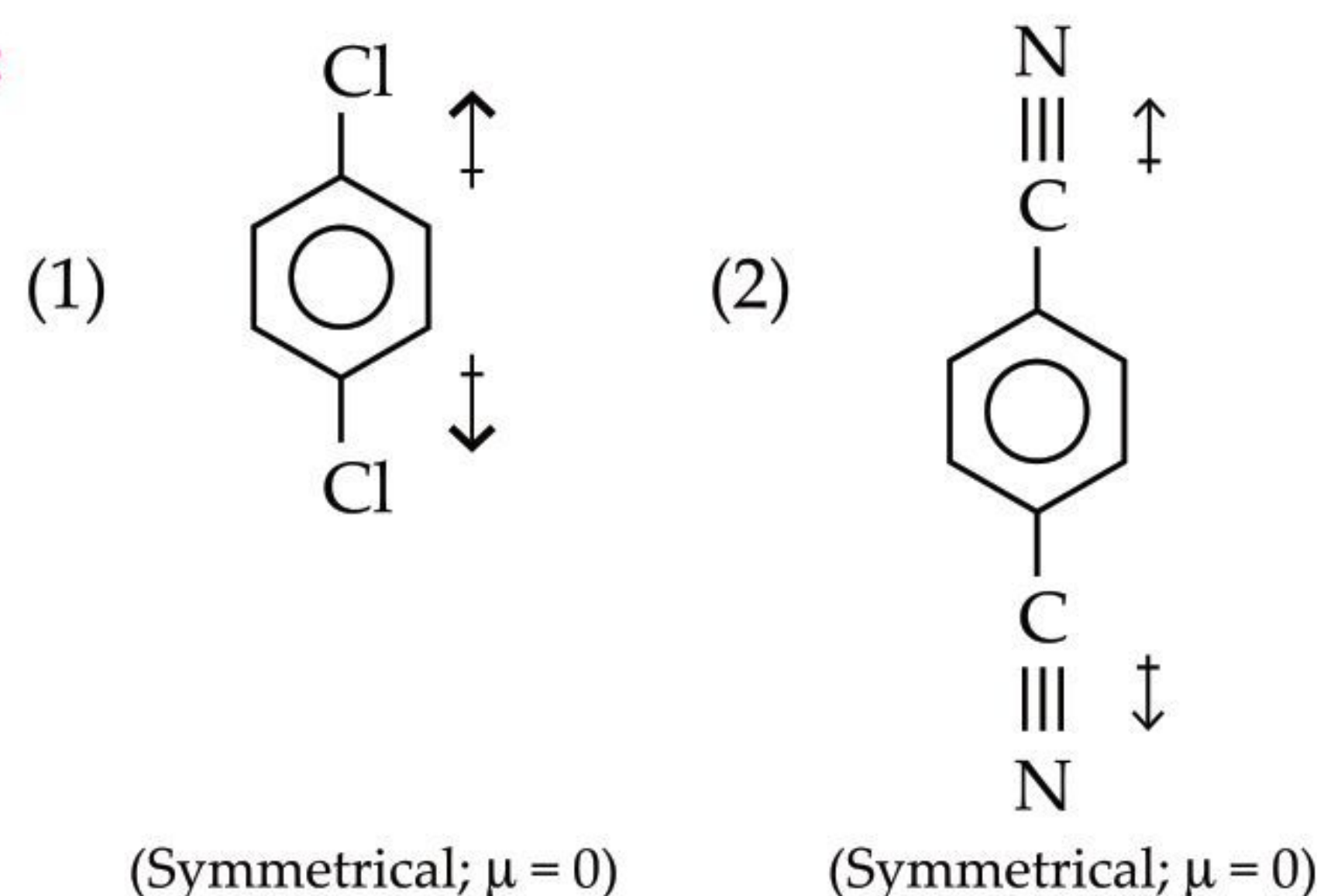


14. 11.14 g of 1,1,2,2-tetrachloropropane was heated with zinc dust and the product was bubbled through ammoniacal AgNO₃. The mass of precipitate obtained is _____.

15. The enthalpy change involved in the oxidation of glucose is -2880 kJ mol⁻¹. 25% of this energy is available for muscular work. If 100 kJ of muscular work is needed to walk 1 km, the maximum distance a person can walk after consuming 125 g of glucose will be _____.

SOLUTIONS

1. (a):



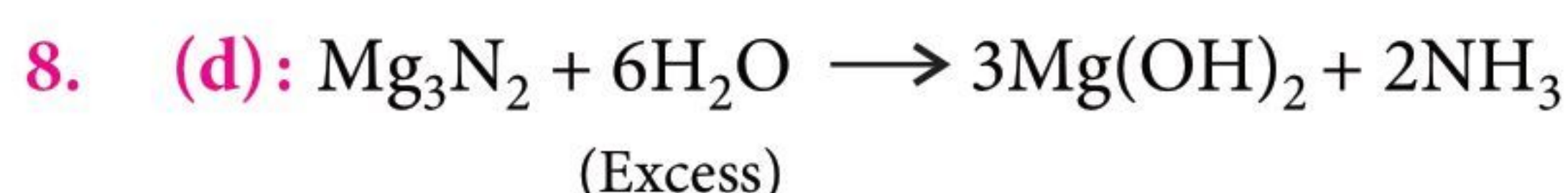
2. (d): pH of a salt of a weak acid and a weak base is given by:

$$\text{pH} = 7 + \frac{1}{2} (\text{p}K_a - \text{p}K_b) = 7 + \frac{1}{2} (3.2 - 3.4) = 6.9$$

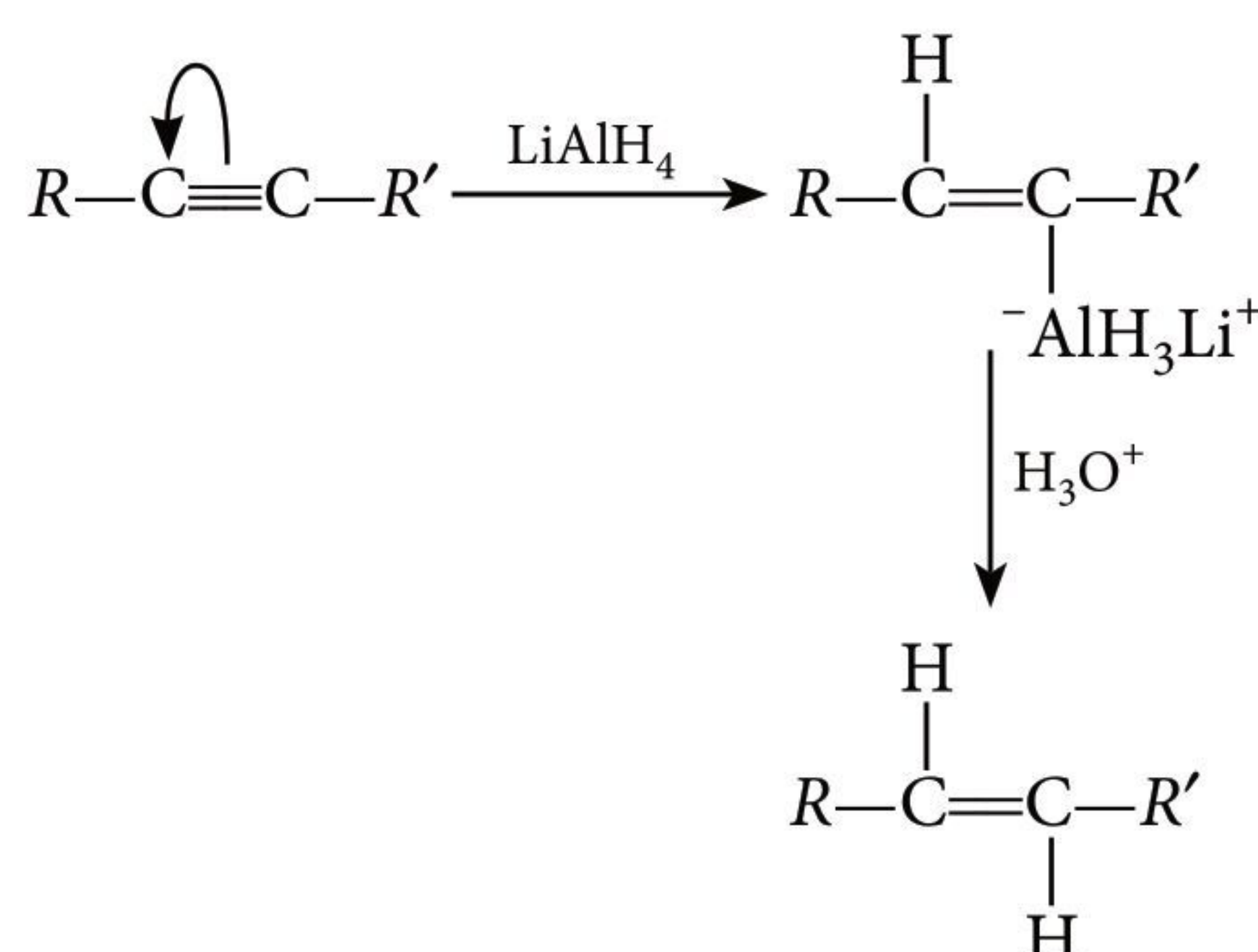
$$\begin{array}{ccccccc} \overset{-1}{6\text{I}^-} + \text{ClO}_3^- + \overset{+6}{6\text{H}_2\text{SO}_4} & \longrightarrow & \text{Cl}^- + \overset{+6}{6\text{HSO}_4^-} + \overset{0}{3\text{I}_2} + 3\text{H}_2\text{O} \\ | & & & & & & \uparrow \\ & \text{oxidized (increase in O.N.)} & & & & & \end{array}$$

4. (d): There is maximum $p\pi-p\pi$ back bonding in BF_3 due to identical size of $2p$ orbitals of B and F.

7. (c):

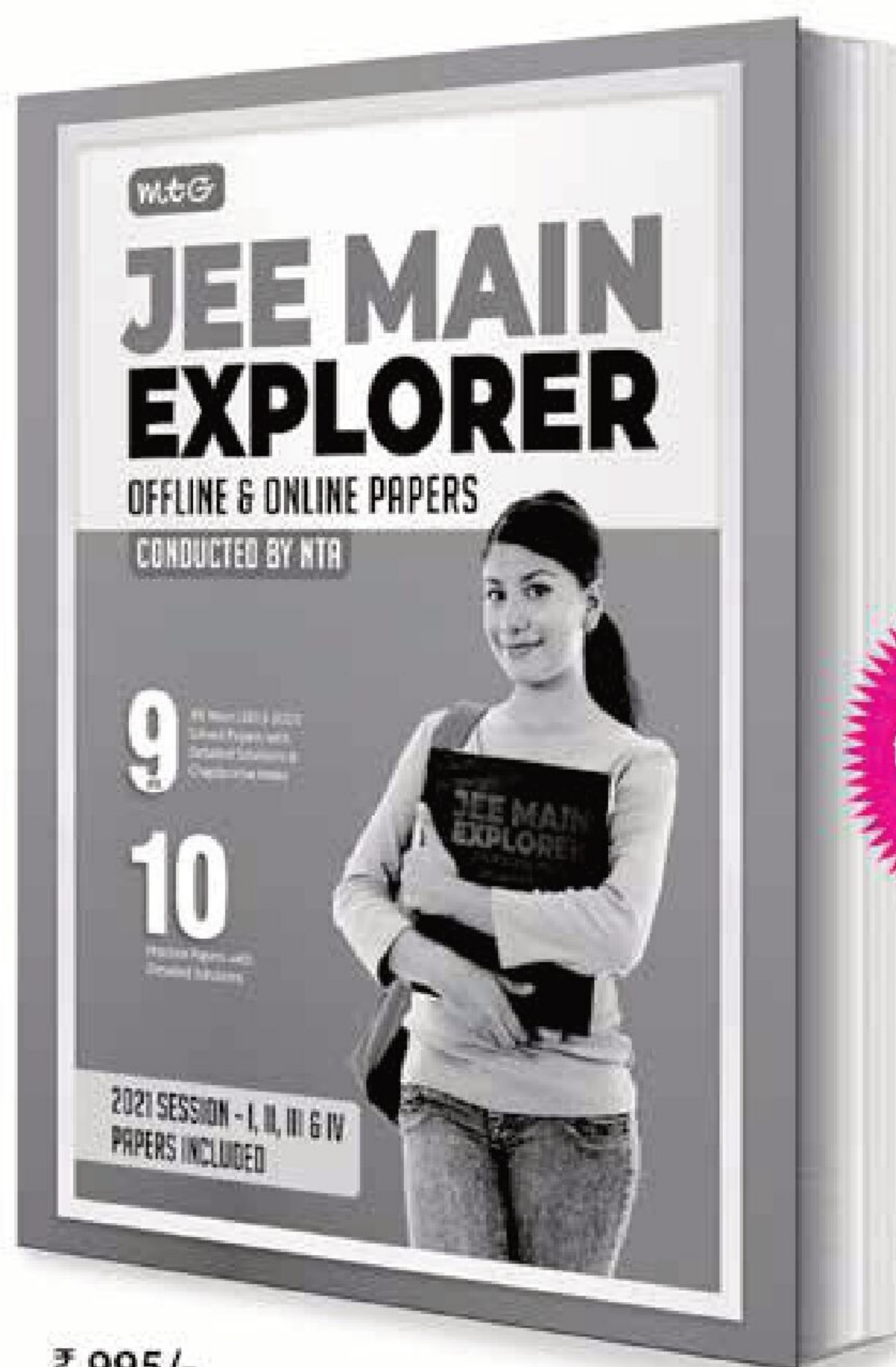


10. (d) : For *trans* products, we should take Na or Li metal in NH_3 or EtNH_2 at low temperature or LiAlH_4 as reducing agent (anti-addition).


$$\begin{aligned}\text{Minimum molecular mass} &= 15 + 15 + 27 + 35.5 \\ &= 92.5\end{aligned}$$

The reaction scheme shows the synthesis of p-bromophenol (S) from aniline (P).
 1. Aniline (P) reacts with excess Br_2 in H_2O to form 3,4-dibromoaniline.
 2. 3,4-dibromoaniline reacts with $\text{NaNO}_2 + \text{HCl}$ at 273 K to form 3,4-dibromo-2-nitroaniline (shown as a diazonium salt N_2^+Cl^-).
 3. This intermediate reacts with CuCN/KCN to form 3,4-dibromo-2-cyanobenzonitrile.
 4. Hydrolysis with H_3O^+ and Δ yields 3,4-dibromobenzoic acid.
 5. Reaction with SOCl_2 in pyridine gives 3,4-dibromobenzoyl chloride.
 6. Further reaction with SOCl_2 in pyridine yields 3,4-dibromobenzoyl chloride (labeled Q).
 7. Separately, benzene (R) is nitrated with oleum and NaOH, H^+ to form phenol.
 8. Phenol is then brominated with Br_2 in CS_2 at 273 K to form p-bromophenol (S).

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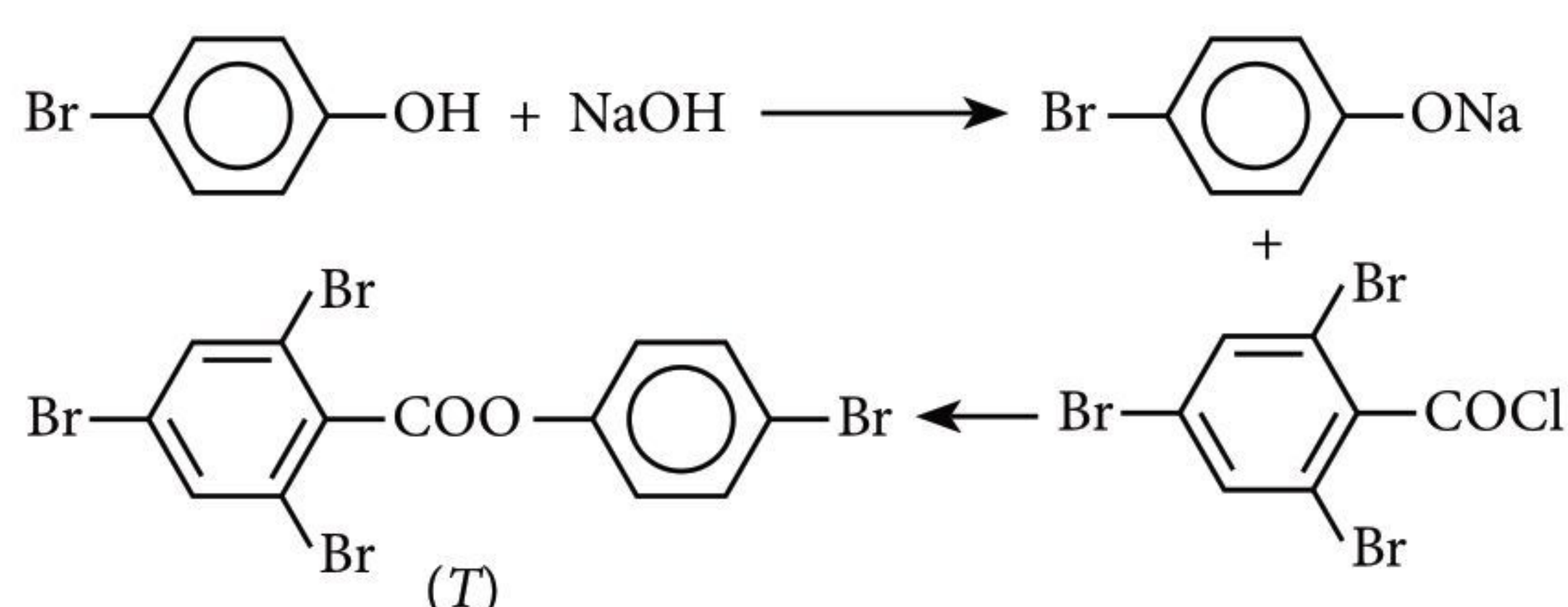
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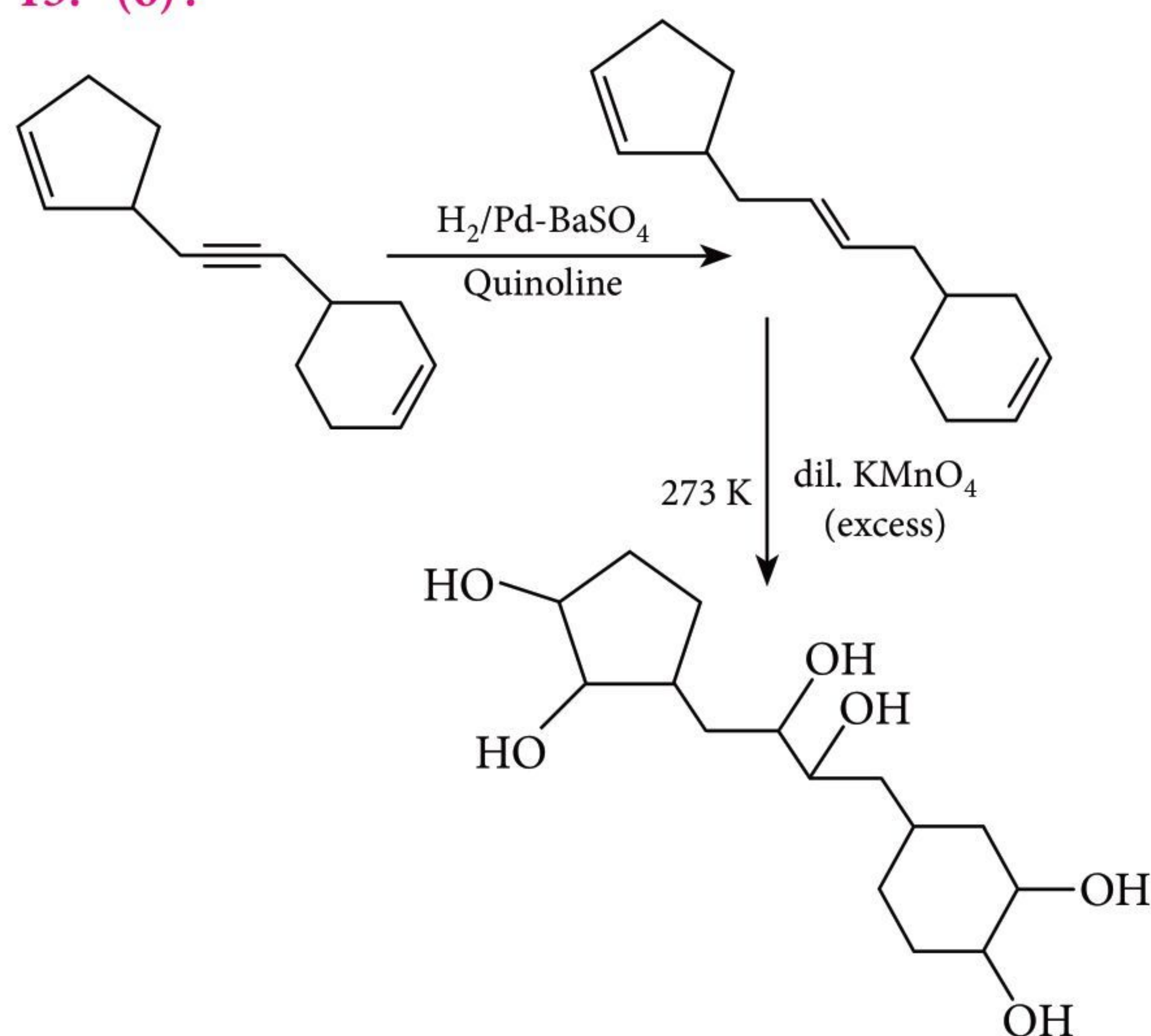
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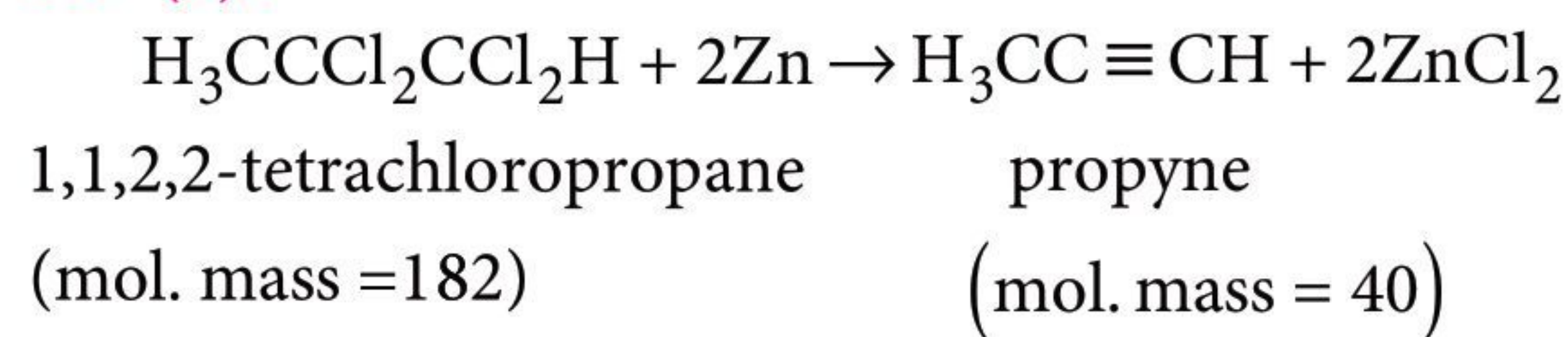
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13. (6):

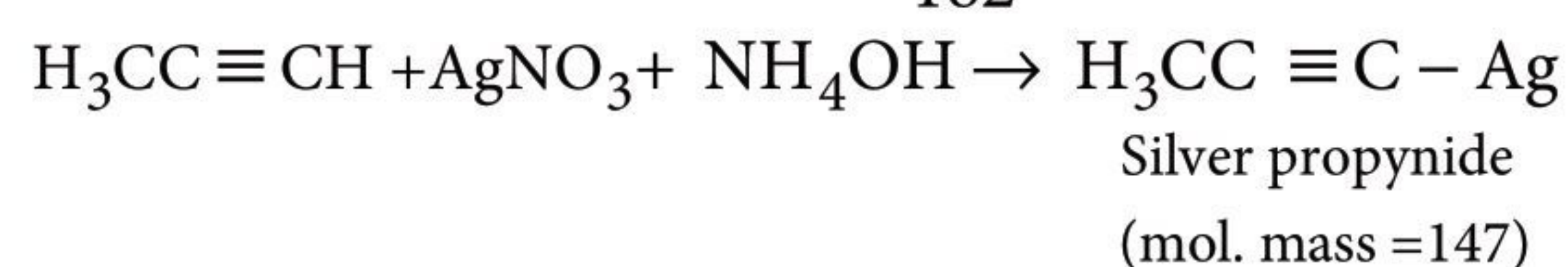


14. (9):



Mass of propyne obtained from 11.14 g of

$$\text{1,1,2,2-tetrachloropropane is } \frac{40}{182} \times 11.14 \text{ g} = 2.45 \text{ g}$$



Mass of precipitate obtained from 2.45 g of propyne

$$= \frac{147}{40} \times 2.45 = 9 \text{ g}$$

15. (5): Energy available for muscular work

$$= \frac{2880 \times 25}{100} = 720 \text{ kJ mol}^{-1}$$

∴ Energy obtained from 125 g of glucose

$$= \frac{720 \times 125}{180} = 500 \text{ kJ}$$

Given, 100 kJ energy is used to walk 1 km.

∴ 500 kJ is used to walk 5 km.

Thus, the maximum distance a person can walk is 5 km.



Scientist of the Month

Sir Frederick Augustus Abel

Early Life and Education

- Born in London as son of Johann Leopold Abel, Abel studied chemistry at the Royal Polytechnic Institution and in 1845 became one of the original 26 students of A. W. von Hofmann at the Royal College of Chemistry. In 1852, he was appointed lecturer in chemistry at the Royal Military Academy, Woolwich, succeeding Michael Faraday, who had held that post since 1829. From 1854 until 1888 Abel served as ordnance chemist at the Chemical Establishment of the Royal Arsenal at Woolwich.



Sir Frederick Augustus Abel
(17 July 1827 - 6 September 1902)

Notable Work

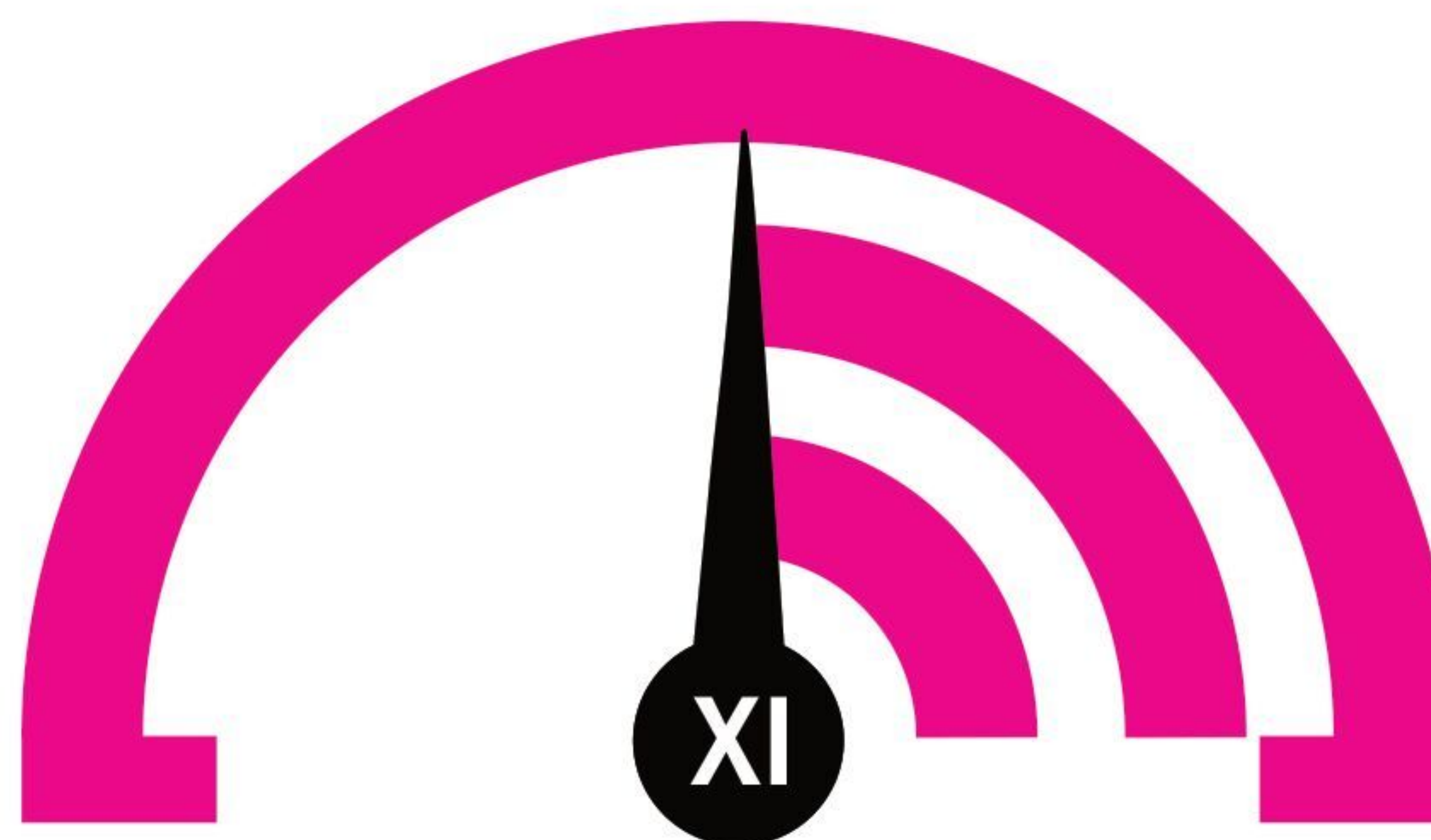
- Manufacture of guncotton, consisting essentially of reducing the nitrated cotton to fine pulp. This work to an important extent prepared the way for the "smokeless powders".
- He also extensively researched the behaviour of black powder when ignited, with the Scottish physicist Sir Andrew Noble.
- At the request of the British government, he devised the Abel test, a means of determining the flash point of petroleum products.
- His first instrument, the open-test apparatus, was specified in an Act of Parliament in 1868 for officially specifying petroleum products.

- It was superseded in August 1879 by the much more reliable Abel close-test instrument. Under his leadership, first, guncotton was developed at Waltham Abbey Royal Gunpowder Mills, patented in 1865, then, the propellant cordite, patented in 1889. In electricity, Abel studied the construction of electrical fuses and other applications of electricity to warlike purposes.

Honors

- He was elected a Fellow of the Royal Society in 1860.
- He received their Royal Medal in 1887.
- He was president of the Chemical Society (1875-77).
- He was also president of the Iron and Steel Institute in 1891.
- He was awarded the Bessemer Gold Medal in 1897 for his work on problems of steel manufacture.
- He was awarded the Telford Medal by the Institution of Civil Engineers in 1879.
- He was made a Commander of the Order of the Bath (CB) in 1877. and knighted on 20 April 1883. He took an important part in the work of the Inventions Exhibition (London) in 1885, and in 1887 became organizing secretary and first director of the Imperial Institute, a position he held till his death in 1902. He was Rede Lecturer and received an honorary doctorate from Cambridge University in 1888. He was upgraded Knight Commander of the Order of the Bath (KCB) on 3 February 1891, created a baronet, of Cadogan Place in the Parish of Chelsea in the County of London, on 25 May 1893 and made a Knight Grand Cross of the Royal Victorian Order (GCVO) on 8 March 1901.

MONTHLY TEST DRIVE



This specially designed column enables students to self analyse their extent of understanding the specified chapter. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120

Chemical Bonding

Time Taken : 60 Min.

NEET

Only One Option Correct Type

- The van der Waals' forces in halogens decrease in the order
(a) $F_2 > Cl_2 > Br_2 > I_2$
(b) $I_2 > Br_2 > Cl_2 > F_2$
(c) $Br_2 > Cl_2 > F_2 > I_2$
(d) $Cl_2 > F_2 > I_2 > Br_2$
- A square planar complex is formed by hybridisation of which atomic orbitals?
(a) s, p_x, p_y, d_{yz} (b) $s, p_x, p_y, d_{x^2-y^2}$
(c) s, p_x, p_y, d_z^2 (d) s, p_y, p_z, d_{xy}
- Among the following, the paramagnetic compound is
(a) Na_2O_2 (b) O_3
(c) N_2O (d) KO_2
- Which of the following molecular species has unpaired electron(s)?
(a) N_2 (b) F_2
(c) O_2^- (d) O_2^{2-}
- Hydrogen bonding is not present in
(a) glycerine (b) water
(c) hydrogen sulphide (d) hydrogen fluoride.
- $H-\overset{(I)}{N} \cdots \overset{(II)}{N} \cdots N$
In hydrogen azide (above) the bond orders of bonds (I) and (II) are

(I)	(II)
(a) > 2	< 2
(b) < 2	< 2
(c) < 2	> 2
(d) > 2	> 2
- For BCl_3 , $AlCl_3$ and $GaCl_3$ the increasing order of ionic character is
(a) $BCl_3 < AlCl_3 < GaCl_3$
(b) $GaCl_3 < AlCl_3 < BCl_3$
(c) $BCl_3 < GaCl_3 < AlCl_3$
(d) $AlCl_3 < BCl_3 < GaCl_3$
- The correct order of boiling point in the following compounds is
(a) $HF > H_2O > NH_3$
(b) $H_2O > HF > NH_3$
(c) $NH_3 > H_2O > HF$
(d) $NH_3 > HF > H_2O$
- The shape of XeO_2F_2 molecule is
(a) trigonal bipyramidal
(b) square planar
(c) tetrahedral
(d) see-saw.
- Which molecule has distorted octahedral shape?
(a) SF_6 (b) PCl_6^-
(c) $[Ni(NH_3)_6]SO_4$ (d) XeF_6
- Which of the following orbital overlappings is not possible according to VBT?

(a)

(b)

(c)

(d) All of these
- Pick out the isoelectronic structures from the following

I. CH_3^+	II. H_3O^+
III. NH_3	IV. CH_3^-

(a) I and II only (b) III and IV only
(c) I and III only (d) II, III and IV only

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
- (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
- (c) If assertion is true but reason is false.
- (d) If both assertion and reason are false.

13. Assertion : All F — S — F angles in SF₄ are greater than 90° but less than 180°.

Reason : The lone pair-lone pair repulsion is weaker than bond pair-bond pair repulsion.

14. Assertion : In change from PCl₃ → PCl₅, the hybrid state of P changes.

Reason : *d*-orbitals are not available for P to expand its octet.

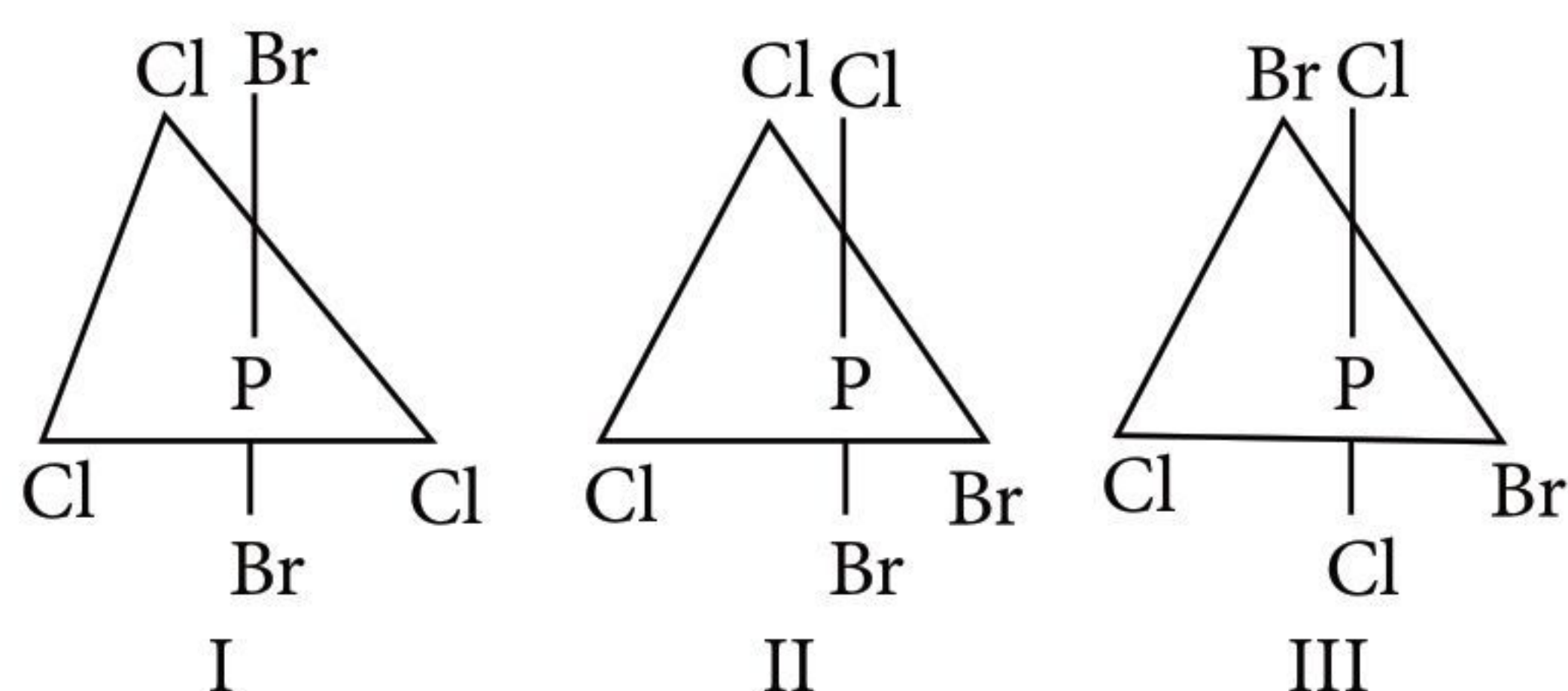
15. Assertion : *p*-Hydroxybenzoic acid has a higher boiling point than *o*-hydroxybenzoic acid.

Reason : *p*-Hydroxybenzoic acid has intramolecular hydrogen bonding whereas *o*-hydroxybenzoic acid has intermolecular hydrogen bonding.

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

16. PBr₂Cl₃ can exhibit geometrical isomerism. Geometrical isomers are as follows :



Which of the above mentioned geometrical isomer(s) has/have no dipole(s) ?

- (a) Only II and III
- (b) Only III
- (c) Only I and II
- (d) Only I

17. The correct order of Cl — O bond lengths in ClO[−], ClO₂[−], ClO₃[−] and ClO₄[−] is

- (a) ClO[−] < ClO₂[−] < ClO₃[−] < ClO₄[−]
- (b) ClO₄[−] < ClO₃[−] < ClO₂[−] < ClO[−]
- (c) ClO₃[−] < ClO₄[−] < ClO₂[−] < ClO[−]
- (d) ClO₄[−] = ClO₃[−] = ClO₂[−] = ClO[−]

18. Which of the following molecular orbitals has two nodal planes?

- (a) σ2s
- (b) π2p_y
- (c) π*2p_y
- (d) σ*2p_x

19. The correct order of O—O bond length in O₂, H₂O₂ and O₃ is

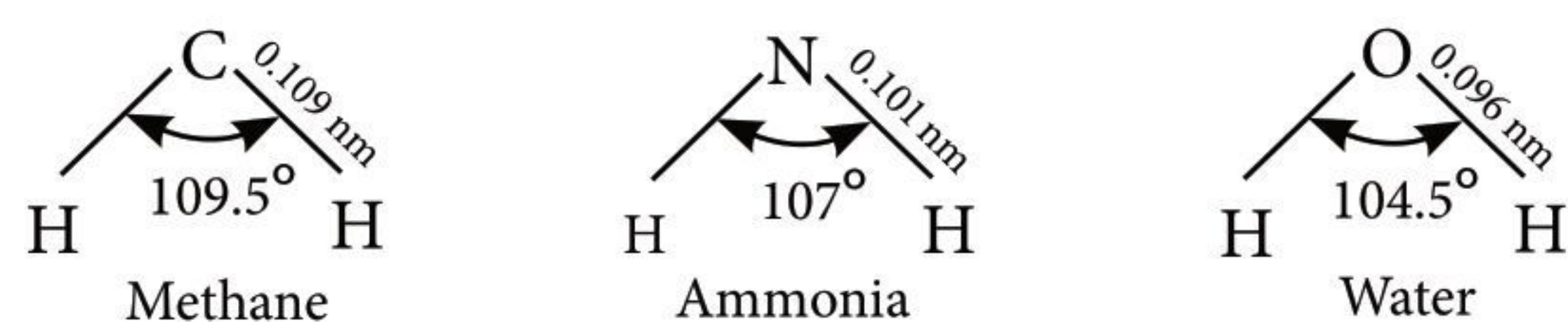
- (a) O₂ > O₃ > H₂O₂
- (b) H₂O₂ > O₃ > O₂
- (c) O₃ > O₂ > H₂O₂
- (d) O₃ > H₂O₂ > O₂

More than One Option Correct Type

20. Which of the following species are hypervalent?

- (a) ClO₄[−]
- (b) BF₃
- (c) SO₄^{2−}
- (d) CO₃^{2−}

21. The bond lengths and bond angles in the molecules of methane, ammonia and water may be represented as follows :

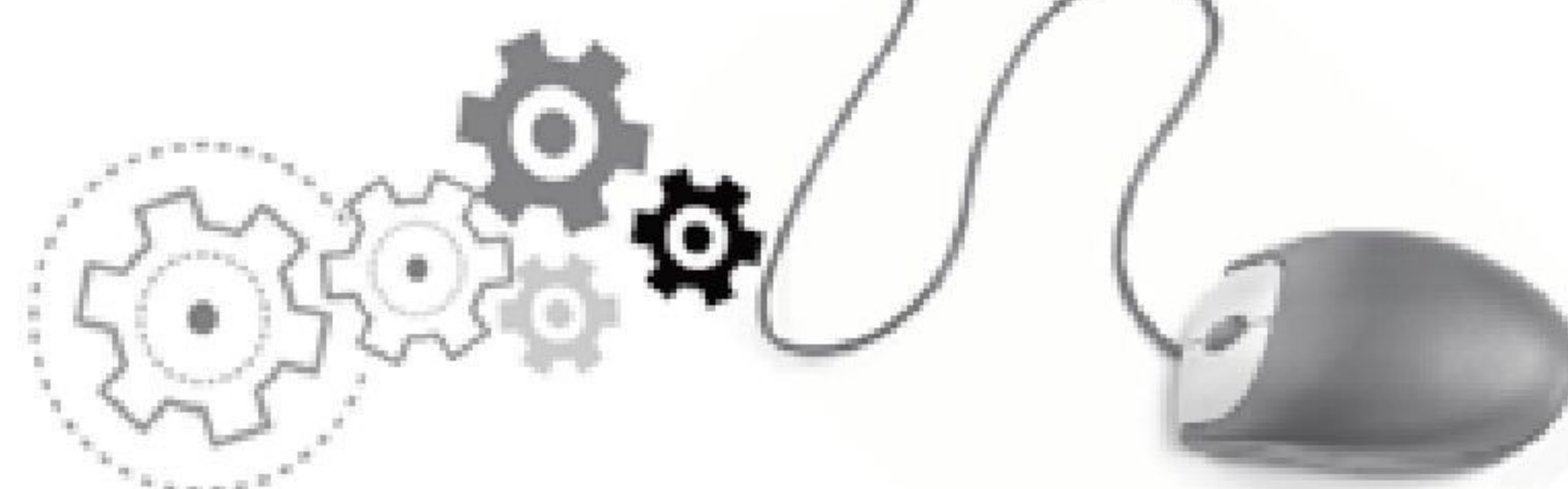


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- Choose the correct statement regarding the trend.
- Increasing *s*-character in bonding hybridised orbital cause decrease in bond length.
 - Increasing repulsion between hydrogen atoms cause bond length to decrease.
 - A decrease in bond angle is caused due to decrease in bond pair-bond pair repulsion.
 - Bond angle decreases due to increase in non-bonding electron pair.

22. In which of the following species bond angle is expected to be more than 120°?

- PCl₄⁺
- NO₂⁻
- NO₂⁺
- XeF₂

23. CO₂ is isostructural with

- HgCl₂
- SnCl₂
- C₂H₂
- NO₂

Integer / Numerical Value Type

24. In [Ag(CN)₂]⁻, the number of π bonds are _____.

25. The maximum number of hybrid orbitals present in a plane in C₂H₆ are _____.

26. Percentage of ionic character in HI bond if $\chi_H = 2.1$, $\chi_I = 2.5$ is _____.

Comprehension Type

Consider the processes listed below :

Reaction	Δ <i>H</i> , kcal/mol
Na _(s) → Na _(g)	25.9
1/2 Cl _{2(g)} → Cl _(g)	29.0 (per mole of Cl atoms)
Na _(g) → Na _(g) ⁺ + e ⁻	119.9
Cl _(g) + e ⁻ → Cl _(g) ⁻	- 86.8
NaCl _(s) → Na _(s) + $\frac{1}{2}$ Cl _{2(g)}	98.2
NaCl _(s) → Na _(aq) ⁺ + Cl _(aq) ⁻	0.9

27. In the above process, the strength of covalent bond is

- 58.0 kcal/mol
- 29.0 kcal/mol
- 14.5 kcal/mol
- 98.2 kcal/mol

28. In the above process, electron affinity of a positive ion is

- 119.9 kcal/mol
- 119.9 kcal/mol
- 0.9 kcal/mol
- 0.9 kcal/mol

Matrix Match Type

29. Match column I with Column II and select the correct option

Column I (Compounds of Xe)	Column II (Shape)		
P. XeF_4	1. Distorted octahedral		
Q. XeOF_4	2. Square planar		
R. XeO_3	3. Pyramidal		
S. XeF_6	4. Square pyramidal		
P	Q	R	S
(a) 4	1	2	3
(b) 4	1	3	2
(c) 2	3	1	4
(d) 2	4	3	1

30. Match the column-I with column-II and select the correct option.

Column-I (Hybridisation)	Column-II (Compounds)		
P. sp^2	1. ICl_4^-		
Q. dsp^2	2. $\text{Fe}(\text{CO})_5$		
R. sp^3d	3. SnCl_2		
S. sp^3d^2	4. $[\text{Ni}(\text{CN})_4]^{2-}$		
P	Q	R	S
(a) 3	4	2	1
(b) 3	4	1	2
(c) 4	1	2	3
(d) 4	3	1	2



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No. of questions attempted

No. of questions correct

Marks scored in percentage

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

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1. Structure of a mixed oxide is cubic close packed (c.c.p.). The cubic unit cell of mixed oxide is composed of oxide ions. One fourth of the tetrahedral voids are occupied by divalent metal A and the octahedral voids are occupied by a monovalent metal B. The formula of the oxide is

(a) ABO_2 (b) A_2BO_2
(c) $A_2B_3O_4$ (d) AB_2O_2

2. For a chemical reaction at 27°C , the activation energy is 600 R . The ratio of the rate constants at 327°C to that of at 27°C will be

(a) 2 (b) 40 (c) e (d) e^2

3. According to Hardy Schulze law, the flocculating power of an ion increases with

(a) decrease in size (b) increase in size
(c) decrease in charge (d) increase in charge.

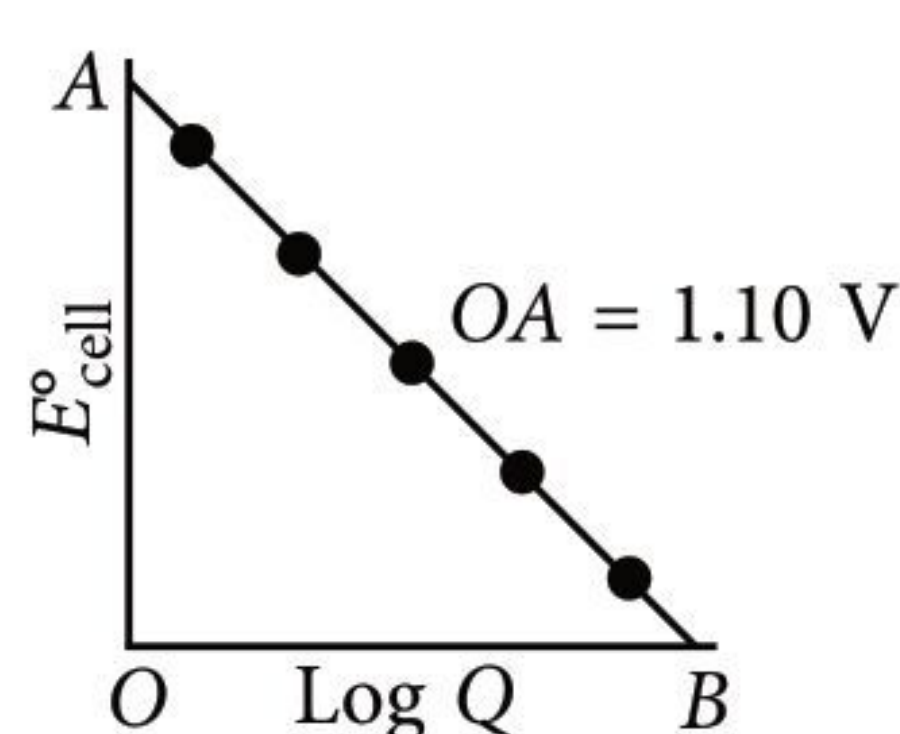
4. Carbon monoxide forms volatile compound with

(a) Ni (b) Cu (c) Al (d) Si

5. $\text{Zn} + \text{Cu}_{(aq)}^{2+} \rightleftharpoons \text{Cu} + \text{Zn}_{(aq)}^{2+}$

Reaction quotient,

$$Q = \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]}$$



Variation of E°_{cell} with $\log Q$ is shown in the figure. E_{cell} will be 1.1591 V when

- (a) $[\text{Cu}^{2+}]/[\text{Zn}^{2+}] = 0.1$
(b) $[\text{Cu}^{2+}]/[\text{Zn}^{2+}] = 0.01$
(c) $[\text{Zn}^{2+}]/[\text{Cu}^{2+}] = 0.01$
(d) $[\text{Zn}^{2+}]/[\text{Cu}^{2+}] = 0.1$

6. Which of the following is arranged in order of decreasing thermal stability?

(a) $\text{Zn} > \text{Hg} > \text{Cd}$ (b) $\text{Cd} > \text{Hg} > \text{Zn}$
(c) $\text{Zn} > \text{Cd} > \text{Hg}$ (d) $\text{Hg} > \text{Cd} > \text{Zn}$

7. Which of the following is not correct?

(a) XeO_3 has four σ and four π bonds.
(b) The hybridization of Xe in XeF_4 is sp^3d^2 .
(c) Among the noble gases the occurrence (percent by weight) of argon is highest in air.
(d) Liquid helium is used in cryogenic liquids.

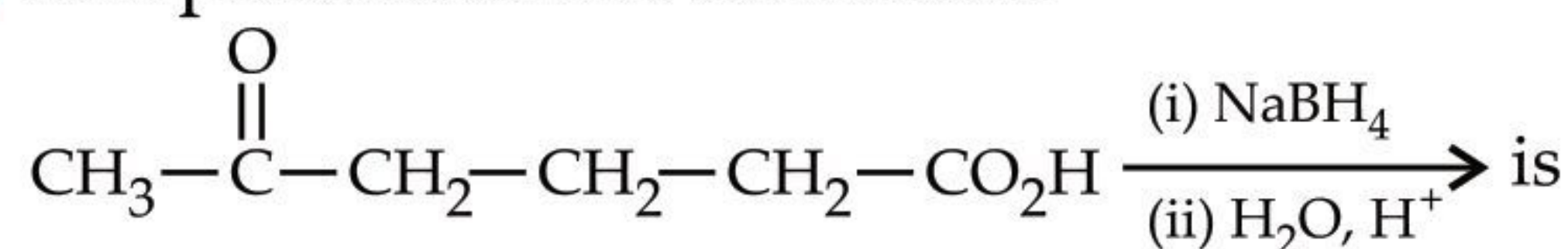
8. There is very little difference in acid strength in the series H_3PO_3 and H_3PO_2 because

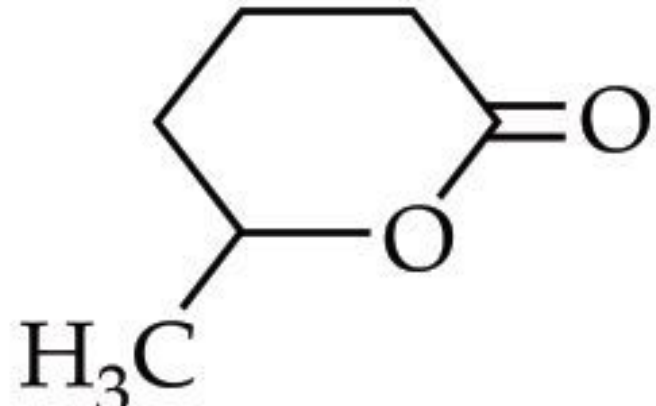
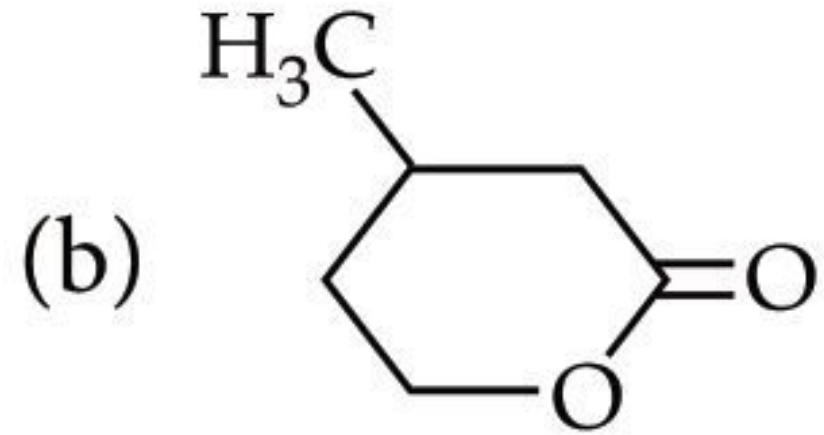
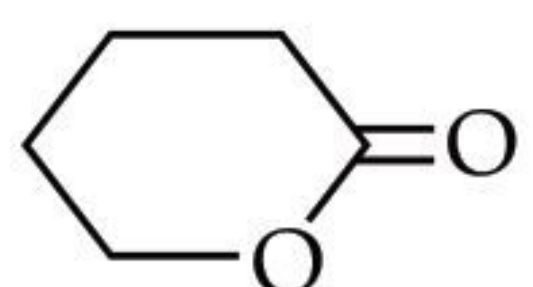
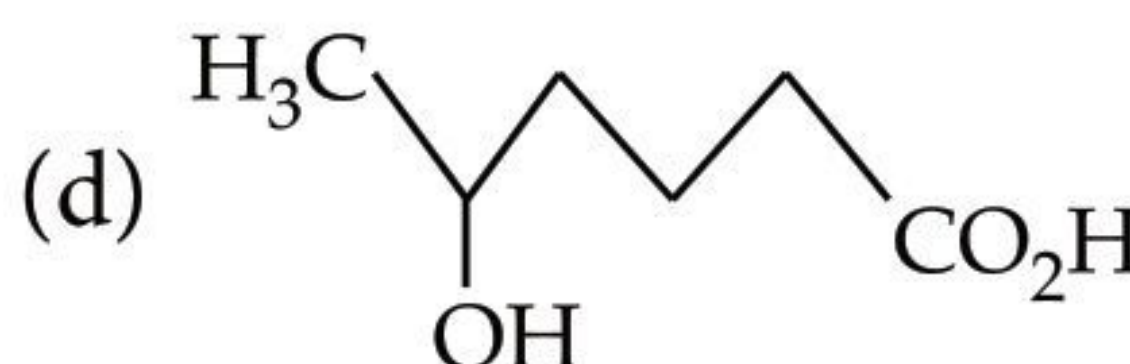
(a) phosphorus in these acids exists in different oxidation states
(b) number of unprotonated oxygen responsible for increase of acidity due to inductive effect remains the same
(c) phosphorus is not a highly electronegative element
(d) phosphorus oxides are less basic.

9. Which of the following complexes exhibit optical isomerism?

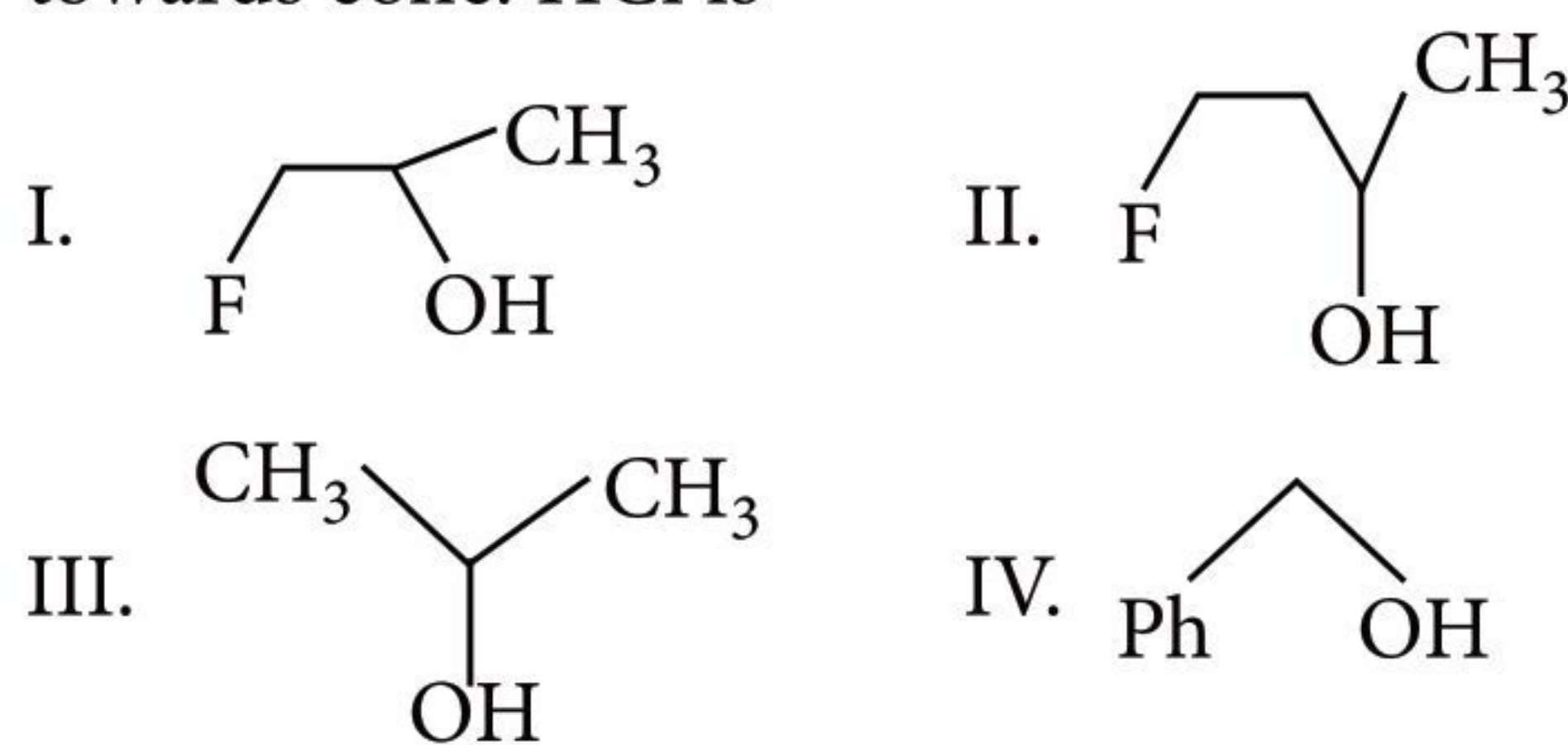
- (a) *Trans*-tetraamminedithiocyanatochromium (III) ion
- (b) *Cis*-diamminedicarbonatocobaltate(III) ion
- (c) *Trans*-diamminedicarbonatocobaltate(III) ion
- (d) *Cis*-bis(glycinato)platinum(II)

10. End product of this conversion



- (a) 
- (b) 
- (c) 
- (d) 

11. The order of reactivity of the following alcohols towards conc. HCl is



- (a) I > II > III > IV
- (b) I > III > II > IV
- (c) IV > III > II > I
- (d) IV > III > I > II

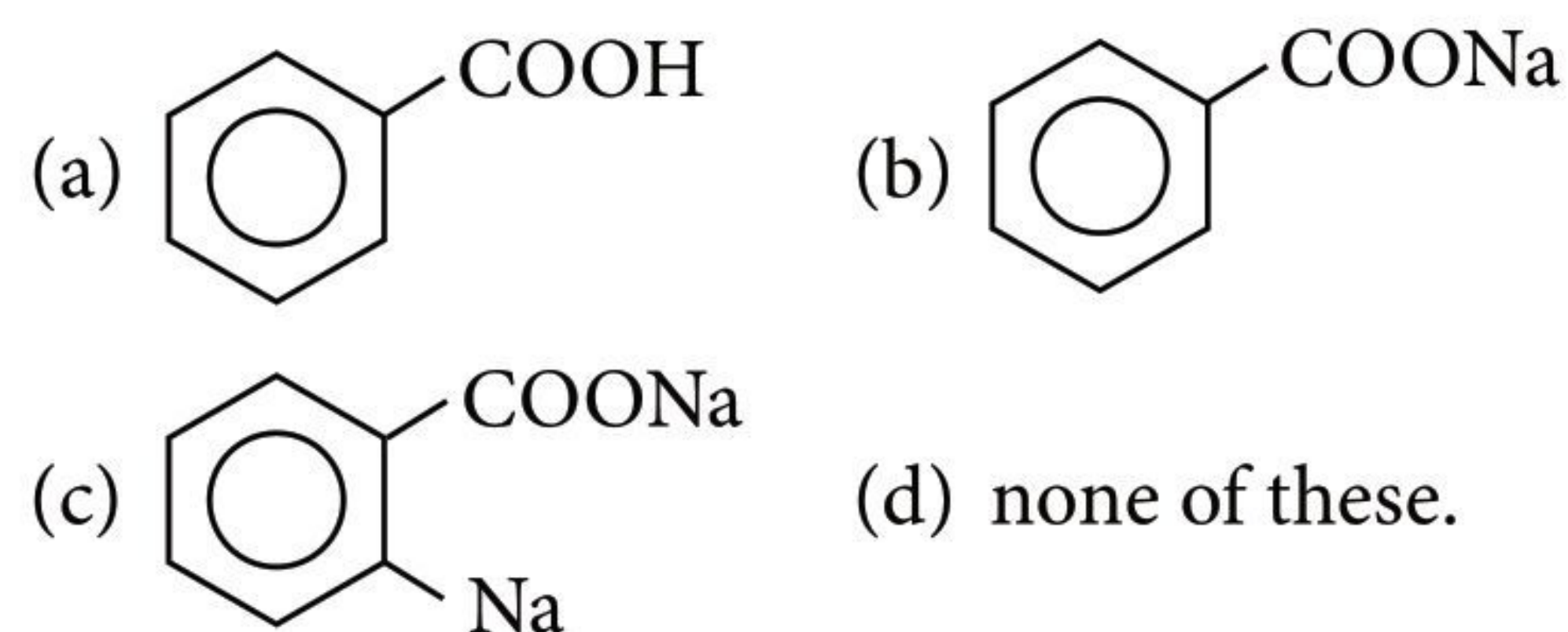
12. An incorrect statement with respect to S_N1 and S_N2 mechanisms for alkyl halide is

- (a) a strong nucleophile in an aprotic solvent increases the rate or favours S_N2 reaction
- (b) competing reaction for an S_N2 reaction is rearrangement
- (c) S_N1 reactions can be catalysed by some Lewis acids
- (d) a weak nucleophile and a protic solvent increases the rate or favours S_N1 reaction.

13. The degree of dissociation of $\text{Ca}(\text{NO}_3)_2$ in a dilute aqueous solution containing 14 g of salt per 200 g of water at 100°C is 70%. If the vapour pressure of water at 100°C is 760 mm, the vapour pressure of the solution would be

- (a) 75
- (b) 7.46
- (c) 746
- (d) none of these.

14. Toluene reacts with excess of Cl_2 in presence of sunlight to give a product which on hydrolysis followed by reaction with NaOH gives



15. Consider the following compounds:

- (I) Glycine
- (II) Sulphanilic acid
- (III) Anthranilic acid

Which of these compounds can form dipolar (zwitter) ion?

- (a) I and II only
- (b) I, II and III only
- (c) II and III only
- (d) I and III only

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SOLUTIONS

1. (d): Number of ions of O^{2-} in c.c.p. = 4
Number of tetrahedral voids = $2 \times N = 2 \times 4$

Number of A^{2+} ions = $8 \times \frac{1}{4} = 2$

Number of octahedral voids = Number of B^+ ions = 4

Ratio, $O^{2-} : A^{2+} : B^+ = 4 : 2 : 4 = 2 : 1 : 2$

Formula of oxide = AB_2O_2

$$2. (c): \ln \frac{k_2}{k_1} = \frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

$$\text{or, } \ln \frac{k_2}{k_1} = \frac{600R}{R} \left(\frac{1}{300} - \frac{1}{600} \right)$$

$$\text{or, } \ln \frac{k_2}{k_1} = \frac{600R}{R} \left(\frac{2-1}{600} \right) = 1 \quad \text{or, } \ln \frac{k_2}{k_1} = \ln e$$

$$\frac{k_2}{k_1} = e$$

3. (d): Greater the valency of the flocculating ion, greater is its flocculating power.

4. (a): Nickel on heating in a stream of carbon monoxide forms a volatile complex, nickel tetracarbonyl.
$$Ni + 4CO \xrightarrow{330-350\text{ K}} [Ni(CO)_4]$$

$$5. (c): E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.0591}{2} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

From the given plot, $OA = E^\circ_{\text{cell}} = 1.10\text{ V}$

$$1.1591 = 1.10 - \frac{0.0591}{2} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

$$\log \frac{[Zn^{2+}]}{[Cu^{2+}]} = -2$$

Taking antilog, $[Zn^{2+}]/[Cu^{2+}] = 0.01$

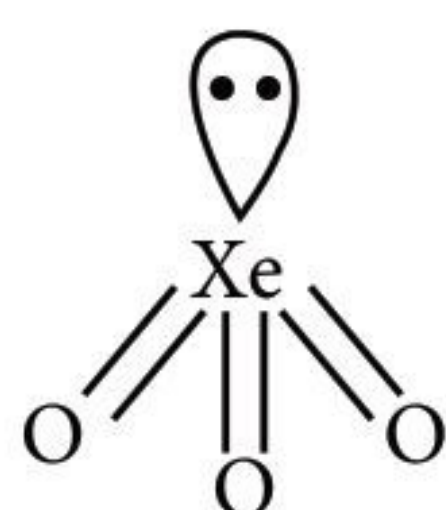
6. (c): Melting point of Zn, Cd, and Hg follows the order: $Zn > Cd > Hg$.

Higher the m.pt., higher will be the thermal stability.

Hence order of thermal stability is

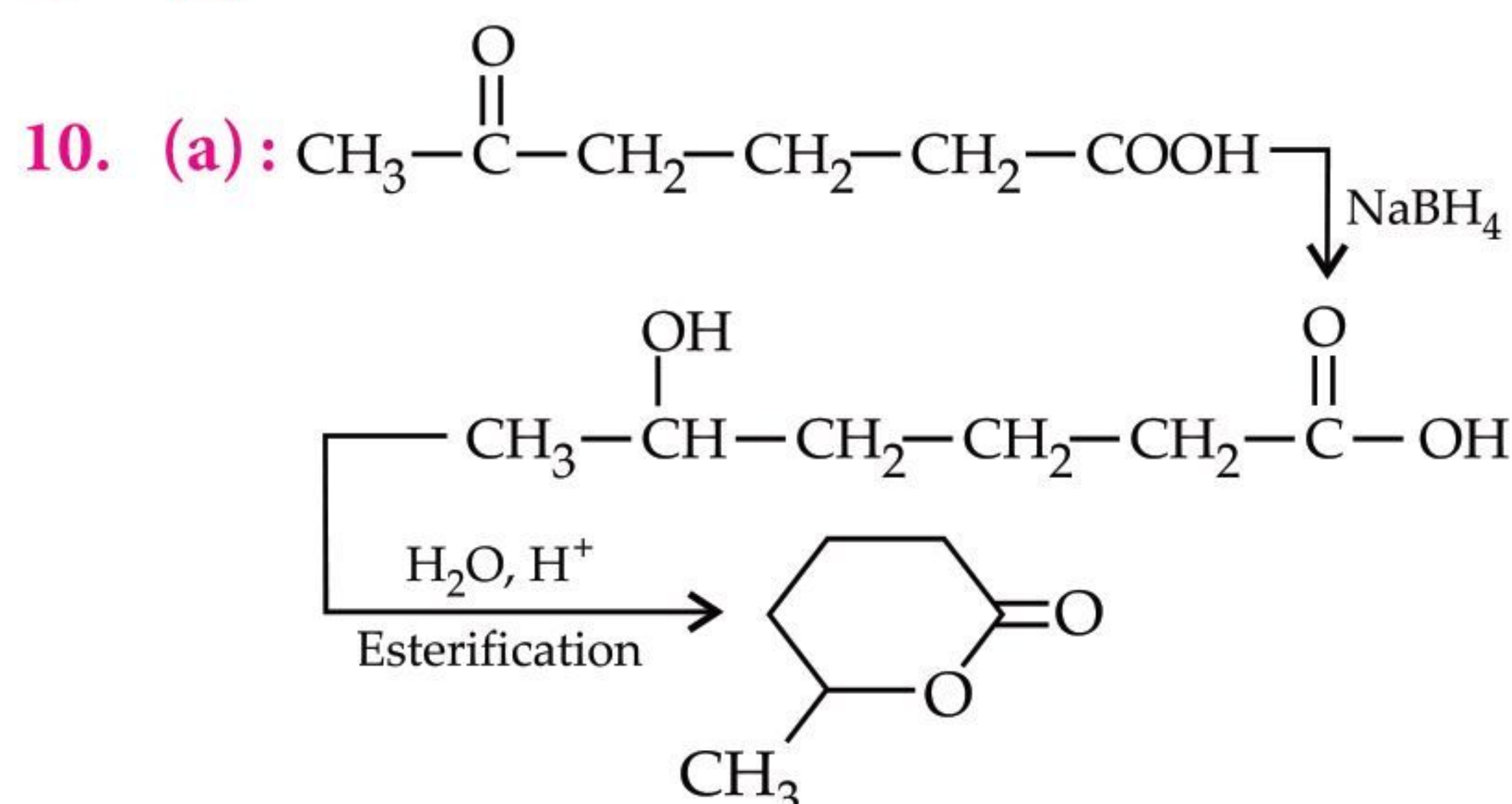
$Zn > Cd > Hg$.

7. (a): XeO_3 has 3 σ and 3 π bonds.



8. (b): H_3PO_4 , H_3PO_3 and H_3PO_2 all have equal number of unprotonated oxygen responsible for increase of acidity. So they have very little difference in acid strength.

9. (b)



11. (c)

12. (b): Rearrangement occurs in S_N1 mechanism.

13. (c): $Ca(NO_3)_2 \rightleftharpoons Ca^{2+} + 2NO_3^-$

Initial conc.	1	0	0
Eq ^m . conc.	$1 - 0.7$	0.7	1.4

$$\frac{\text{Number of particles after dissociation}}{\text{Number of particles before dissociation}}$$

$$\frac{2.4}{1} = \frac{m_{\text{cal.}}}{m_{\text{exp}}}$$

$$\Rightarrow m_{\text{exp}} = \frac{164}{2.4} = 68.3$$

According to Raoult's law,

$$\frac{p^\circ - p_s}{p^\circ} = \frac{w_1 m_2}{w_2 m_1} \quad \text{or} \quad \frac{760 - p_s}{760} = \frac{14 \times 18}{200 \times 68.33}$$

$$p_s = 746\text{ mm}$$

14. (b)

15. (b)



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A pony!



A unicorn!



A pegasus!



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Time Allowed : 3 hours
Maximum Marks : 70

GENERAL INSTRUCTIONS

General Instructions : Read the following instructions carefully.

- There are 33 questions in this question paper. All questions are compulsory.
- Section A : Q. No. 1 to 16 are objective type questions. Q. No. 1 and 2 are passage based questions carrying 4 marks each while Q. No. 3 to 16 carry 1 mark each.
- Section B : Q. No. 17 to 25 are short answer questions and carry 2 marks each.
- Section C : Q. No. 26 to 30 are short answer questions and carry 3 marks each.
- Section D : Q. No. 31 to 33 are long answer questions carrying 5 marks each.
- There is no overall choice. However, internal choices have been provided.
- Use of calculators and log tables is not permitted.

SECTION - A (OBJECTIVE TYPE)

Read the passage given below and answer the following questions :

- Molar conductivity of ions are given as product of charge on ions to their ionic mobilities and Faraday's constant.

$\lambda_{A^{n+}} = n\mu_{A^{n+}}F$ (here μ is the ionic mobility of A^{n+}).
For electrolytes say A_xB_y , molar conductivity is given by

$$\lambda_{m(A_xB_y)} = x_n\mu_{A^{n+}}F + y_m\lambda_{A^{m-}}F$$

Ions **Ionic mobility**

K^+ 7.616×10^{-4}

Ca^{2+} 12.33×10^{-4}

Br^- 8.09×10^{-4}

SO_4^{2-} 16.58×10^{-4}

The following questions are multiple choice questions. Choose the most appropriate answer.

- At infinite dilution, the equivalent conductance of $CaSO_4$ is

- 256×10^{-4}
- 279
- 23.7
- 2.0×10^{-8}

- If the degree of dissociation of $CaSO_4$ solution is 10% then equivalent conductance of $CaSO_4$ is
(a) 3.59 (b) 36.9 (c) 27.9 (d) 30.6

OR

The correct order of equivalent conductance at infinite dilution of $LiCl$, $NaCl$, KCl is

- $LiCl = NaCl = KCl$
- $LiCl > NaCl > KCl$
- $KCl > LiCl > NaCl$
- $KCl > NaCl > LiCl$

- What is the unit of equivalent conductivity?

- $ohm^{-1} cm^2 eq^{-1}$
- $ohm cm^2 eq^{-1}$
- $ohm^{-1} cm eq^{-1}$
- $ohm cm^{-2} eq^{-1}$

- If the molar conductance value of Ca^{2+} and Cl^- at infinite dilution are $118.88 \times 10^{-4} m^2 mho mol^{-1}$ and $77.33 \times 10^{-4} m^2 mho mol^{-1}$ respectively then the molar conductance of $CaCl_2$ (in $m^2 mho mol^{-1}$) will be

- 120.18×10^{-4}
- 135×10^{-4}
- 273.54×10^{-4}
- 192.1×10^{-4}

Read the passage given below and answer the following questions :

2. The potential of each electrode is known as electrode potential. Standard electrode potential is the potential when concentration of each species taking part in electrode reaction is unity and the reaction is taking place at 298 K. By convention, the standard electrode potential of hydrogen (SHE) is 0.0 V. The electrode potential value for each electrode process is a measure of relative tendency of the active species in the process to remain in the oxidised/reduced form. The negative electrode potential means that the redox couple is stronger reducing agent than H^+/H_2 couple. A positive electrode potential means that the redox couple is a weaker reducing agent than the H^+/H_2 couple. Metals which have higher positive value of standard reduction potential form the oxides of greater thermal stability.

In these questions, Q. No. (i)-(iv), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- (a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
 (b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
 (c) Assertion is correct statement but reason is wrong statement.
 (d) Assertion is wrong statement but reason is correct statement.

- (i) **Assertion :** An electrochemical cell can be set-up only if the redox reaction is spontaneous.

Reason : A reaction is spontaneous if the free energy change is negative.

- (ii) **Assertion :** The standard electrode potential of hydrogen is 0.0 V.

Reason : It is by convention.

OR

Assertion : The more negative is the standard reduction potential, greater is its ability to displace H_2 from acid.

Reason : Strength of reducing agent increases with the increase in negative value of the standard reduction potential.

- (iii) **Assertion :** The negative value of standard reduction potential means that reduction takes place on this electrode with reference to hydrogen electrode.

Reason : The standard electrode potential of a half cell has a fixed value.

- (iv) **Assertion :** The absolute value of electrode potential cannot be determined experimentally.

Reason : The electrode potential values are generally determined with respect to SHE.

Following questions (Q. No. 3-11) are multiple choice questions carrying 1 mark each :

3. The increasing electron releasing tendencies of Cu, Ag, Fe and Zn are in the order
 (a) Ag, Cu, Fe, Zn (b) Cu, Ag, Fe, Zn
 (c) Zn, Cu, Fe, Ag (d) Fe, Zn, Cu, Ag

4. Given below are the standard electrode potentials of few half-cells. The correct order of these metals in increasing reducing power will be

$K^+|K = -2.93$ V, $Ag^+|Ag = 0.80$ V,
 $Mg^{2+}|Mg = -2.37$ V, $Cr^{3+}|Cr = -0.74$ V.

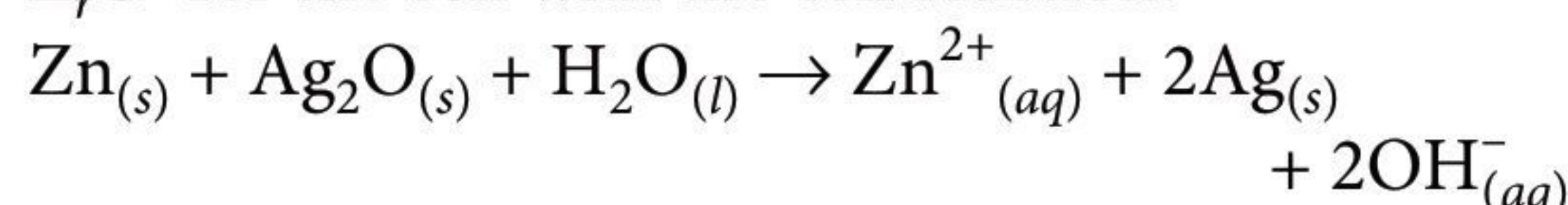
- (a) $K < Mg < Cr < Ag$ (b) $Ag < Cr < Mg < K$
 (c) $Mg < K < Cr < Ag$ (d) $Cr < Ag < Mg < K$

OR

Standard electrode potentials of three metals X, Y and Z are 0.52 V, -2.87 V and -0.44 V respectively. The reducing power of these metals are

- (a) $X > Y > Z$ (b) $X > Z > Y$
 (c) $Y > X > Z$ (d) $Y > Z > X$

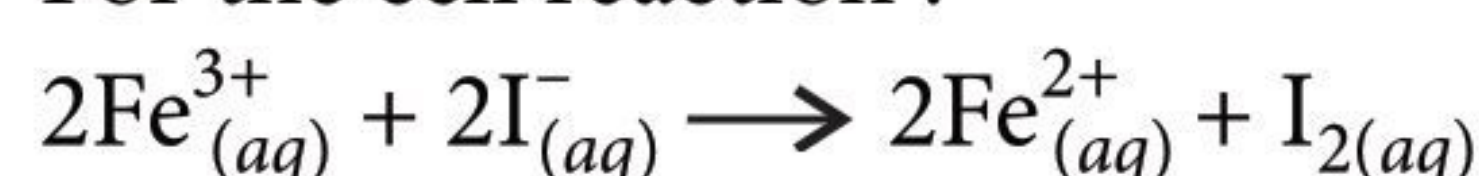
5. $\Delta_r G^\circ$ for the cell with the cell reaction:



$[E^\circ_{Ag_2O/Ag} = 0.344$ V, $E^\circ_{Zn^{2+}/Zn} = -0.76$ V]

- (a) 2.13×10^5 J mol⁻¹ (b) -2.13×10^5 J mol⁻¹
 (c) 1.06×10^5 J mol⁻¹ (d) -1.06×10^5 J mol⁻¹

6. For the cell reaction :



$E^\circ_{cell} = 0.24$ V at 298 K. The standard Gibbs energy ($\Delta_r G^\circ$) of the cell reaction is

[Given that Faraday constant, $F = 96500$ C mol⁻¹]

- (a) 23.16 kJ mol⁻¹ (b) -46.32 kJ mol⁻¹
 (c) -23.16 kJ mol⁻¹ (d) 46.32 kJ mol⁻¹

OR

Which metal is protected from corrosion by a layer of its own oxide?

- (a) Tl (b) Ag (c) Al (d) Au

7. Units of the properties measured are given below. Which of the properties has not been matched correctly?

- (a) Molar conductance = $\text{S m}^2 \text{mol}^{-1}$
 (b) Cell constant = m^{-1}
 (c) Specific conductance = S m^2
 (d) Equivalent conductance = $\text{S m}^2 (\text{g eq})^{-1}$

OR

For a cell involving one electron, $E^\circ_{\text{cell}} = 0.59 \text{ V}$ at 298 K, the equilibrium constant for the cell reaction is [Given that $\frac{2.303RT}{F} = 0.059 \text{ V}$ at $T = 298 \text{ K}$]

- (a) 1.0×10^{30} (b) 1.0×10^2
 (c) 1.0×10^5 (d) 1.0×10^{10}

8. The standard reduction potential for the half-cell reaction, $\text{Cl}_2 + 2e^- \rightarrow 2\text{Cl}^-$ will be

$(\text{Pt}^{2+} + 2\text{Cl}^- \rightarrow \text{Pt} + \text{Cl}_2, E^\circ_{\text{cell}} = -0.15 \text{ V};$
 $\text{Pt}^{2+} + 2e^- \rightarrow \text{Pt}, E^\circ = 1.20 \text{ V})$

- (a) -1.35 V (b) $+1.35 \text{ V}$
 (c) -1.05 V (d) $+1.05 \text{ V}$

OR

Anode reaction of a fuel cell is

- (a) $\text{Zn(Hg)} + 2\text{OH}^- \rightarrow \text{ZnO}_{(s)} + \text{H}_2\text{O} + 2e^-$
 (b) $\text{Pb}_{(s)} + \text{SO}_4^{2-}{}_{(aq)} \rightarrow \text{PbSO}_{4(s)} + 2e^-$
 (c) $2\text{H}_{2(g)} + 4\text{OH}^-{}_{(aq)} \rightarrow 4\text{H}_2\text{O}_{(l)} + 4e^-$
 (d) $2\text{Fe}_{(s)} \rightarrow 2\text{Fe}^{2+} + 4e^-$

9. Which of the following is incorrect in a galvanic cell?

- (a) Oxidation occurs at anode.
 (b) Reduction occurs at cathode.
 (c) The electrode at which electrons are gained is called cathode.
 (d) The electrode at which electrons are lost is called cathode.

10. The electrolyte used in Leclanche cell is

- (a) paste of KOH and ZnO
 (b) 38% solution of H_2SO_4
 (c) moist paste of NH_4Cl and ZnCl_2
 (d) moist sodium hydroxide.

11. Kohlrausch's law states that

- (a) addition of an acid or base to maintain pH
 (b) at infinite dilution, each ion contributes a definite value to the equivalent conductance of the electrolyte depends on their ionisation

(c) at infinite dilution, each ion does not contribute a value to equivalent conductance

(d) at infinite dilution, each ion contributes a definite value to the equivalent conductance of the electrolyte independent of their ionisation.

In the following questions (Q. No. 12 - 16) a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- (a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
 (b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
 (c) Assertion is correct statement but reason is wrong statement.
 (d) Assertion is wrong statement but reason is correct statement.

12. **Assertion :** The observed conductance depends upon the nature of the electrolyte and the concentration of the solution.

Reason : The cell constant of a cell depends upon the nature of the material of the electrodes.

13. **Assertion :** Electrolysis of $\text{NaCl}_{(aq)}$ produces Na metal.

Reason : Hydrogen gas is obtained at cathode.

14. **Assertion :** KCl, NaCl and NH_4Cl cannot be used in the salt bridge of a cell containing silver.

Reason : A salt bridge contains concentrated solution of an inert electrolyte like KNO_3 , K_2SO_4 or solidified solution of such an electrolyte in agar-agar and gelatine.

OR

Assertion : Molar conductivity of a weak electrolyte at infinite dilution cannot be determined experimentally.

Reason : Kohlrausch law helps to find the molar conductivity of a weak electrolyte at infinite dilution.

15. **Assertion :** Conductance of a substance increases with decrease in resistance.

Reason : The inverse of resistance is called conductance.

16. **Assertion :** Pure iron when heated in dry air is covered with a layer of rust.

Reason : Rust has the composition $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$

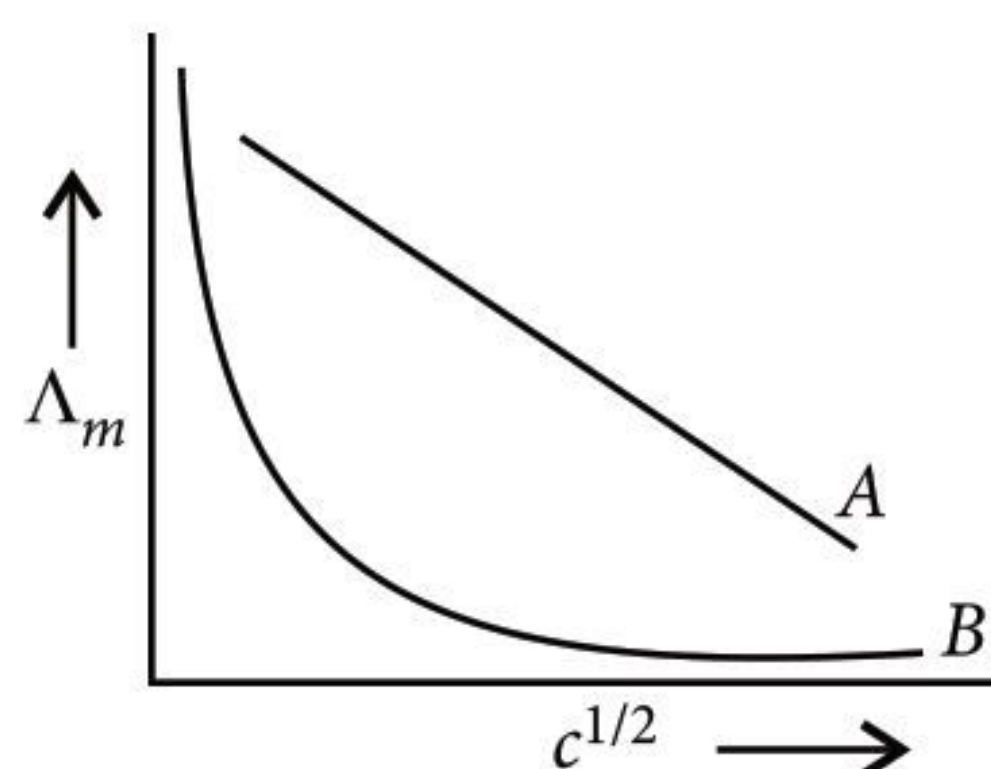
SECTION - B

The following questions, (Q. No. 17-25) are short answer type and carry 2 marks each.

17. (i) Explain why fluorine is the strongest oxidising agent?
 (ii) Lithium metal is the strongest reducing agent. Why?

OR

In the plot of molar conductivity (Λ_m) vs square root of concentration ($c^{1/2}$), following curves are obtained for two electrolytes A and B

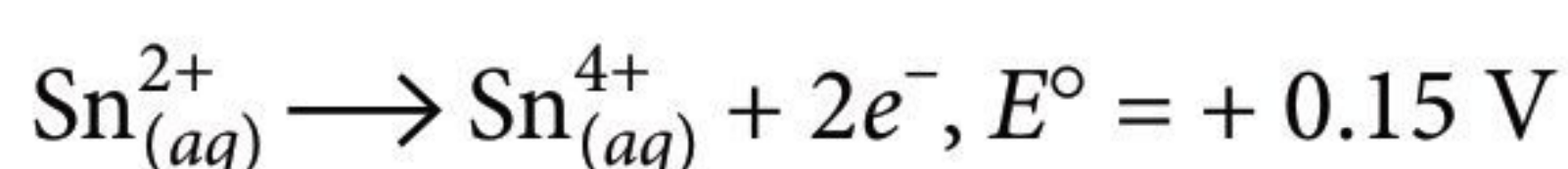
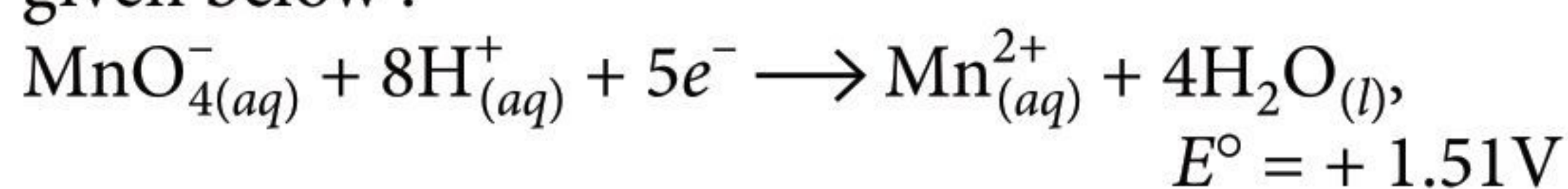


Answer the following :

- (i) Predict the nature of electrolytes A and B.
 (ii) What happens on extrapolation of Λ_m to concentration approaching zero for electrolytes A and B?
18. Equivalent conductivity of a 0.25 N solution is found to be $105.5 \text{ S cm}^2 \text{ eq}^{-1}$. If the two electrodes are 1.9 cm apart and 3.6 cm^2 in area, then calculate the resistance offered by the cell.
19. Write overall reactions involved in the rusting of iron.
20. Determine the value of equilibrium constant (K_c) and ΔG° for the following reaction :
 $\text{Ni}_{(s)} + 2\text{Ag}_{(aq)}^+ \rightarrow \text{Ni}_{(aq)}^{2+} + 2\text{Ag}_{(s)}$, $E^\circ = 1.05 \text{ V}$
 ($1 \text{ F} = 96500 \text{ C mol}^{-1}$)

OR

Two half-reactions of an electrochemical cell are given below :



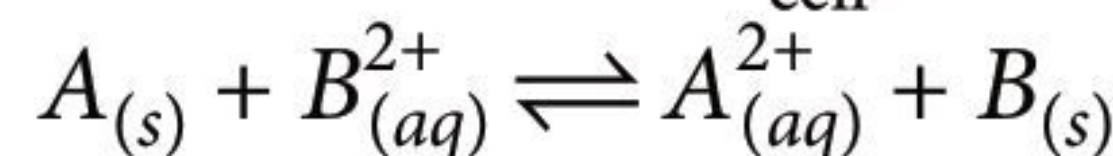
Construct the redox equation from the standard potential of the cell and predict if the reaction is reactant favoured or product favoured.

21. Define limiting molar conductivity. Why conductivity of an electrolyte solution decreases with the decrease in concentration?
22. Why a galvanic cell stops working after sometime?
23. How much electricity in terms of Faradays is required to produce 20 g of calcium from molten CaCl_2 ?

OR

Predict the product of electrolysis of aqueous H_2SO_4 .

24. Equilibrium constant (K_c) for the given cell reaction is 10. Calculate E_{cell}° .



25. Mention the reactions occurring at (i) anode, (ii) cathode, during working of a mercury cell. Why does the voltage of a mercury cell remain constant during its operation?

SECTION - C

Q. No. 26-30 are short answer type II carrying 3 marks each.

26. The equivalent conductivity of 0.05 N solution of a monobasic acid is $15.8 \text{ mho cm}^2 \text{ eq}^{-1}$. If equivalent conductivity of the acid at infinite dilution is $350 \text{ mho cm}^2 \text{ eq}^{-1}$, calculate the (a) degree of dissociation of acid (b) dissociation constant of acid.

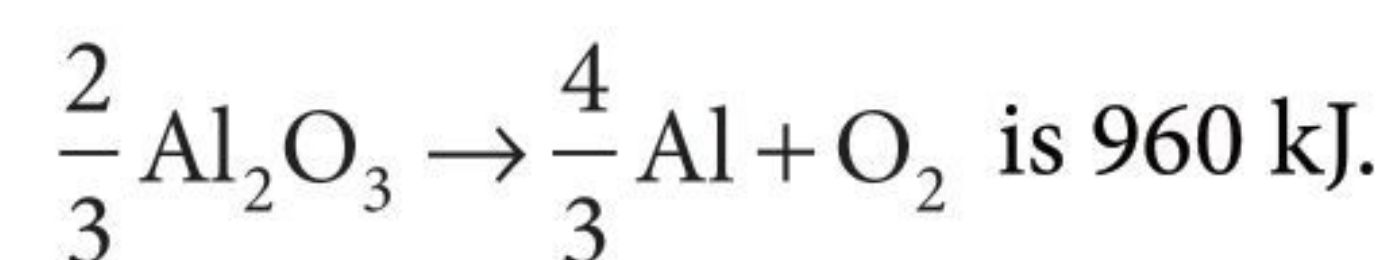
OR

A cell is prepared by dipping copper rod in 1 M copper sulphate solution and zinc rod in 1 M zinc sulphate solution. The standard reduction potential of copper and zinc are 0.34 V and -0.76 V respectively.

- (i) What will be the cell reaction?
 (ii) What will be the standard electromotive force of the cell?
 (iii) Which electrode will be positive?
27. A voltaic cell is set up at 25°C with the following half cells :
 Al/Al^{3+} (0.001 M) and Ni/Ni^{2+} (0.50 M)
 Write an equation for the reaction that occurs when the cell generates an electric current and determine the cell potential.
 $E_{\text{Ni}^{2+}/\text{Ni}}^\circ = -0.25 \text{ V}$ and $E_{\text{Al}^{3+}/\text{Al}}^\circ = -1.66 \text{ V}$.
 ($\log 8 \times 10^{-6} = -5.09$)

OR

Estimate the minimum potential difference needed to reduce Al_2O_3 at 500°C . The Gibbs energy change for the decomposition reaction,



$$(F = 96500 \text{ C mol}^{-1})$$

28. The resistance of 100 cm^3 aqueous solution of 0.025 M CuSO_4 is 520 ohm at 298 K. Calculate the molar conductivity if the cell constant of the conductivity cell is 153.7 m^{-1} .

29. When a certain conductance cell was filled with 0.1 M KCl, it has a resistance of 85 ohms at 25°C. When the same cell was filled with an aqueous solution of 0.052 M unknown electrolyte, the resistance was 96 ohms. Calculate the molar conductance of the electrolyte at this concentration. [Specific conductance of 0.1 M KCl = $1.29 \times 10^{-2} \text{ ohm}^{-1} \text{ cm}^{-1}$]

30. (a) Why Λ_m° for acetic acid cannot be determined experimentally?
 (b) State Kohlrausch's law for electrical conductance of an electrolyte at infinite dilution.
 (c) Calculate the equivalent conductivity at infinite dilution of the salt NaKC_2O_4 . Given ionic molar conductance of oxalate, Na^+ and K^+ ions are 74.1, 50.1 and 73.5 $\text{S cm}^2 \text{ mol}^{-1}$.

SECTION - D

Q. No. 31-33 are long answer type carrying 5 marks each.

31. (a) Calculate standard emf of the cell in which following reaction takes place at 25°C.
 $\text{Cu}_{(s)} + \text{Cl}_{2(g)} \rightleftharpoons \text{Cu}^{2+} + 2\text{Cl}^-$
 $E_{\text{Cl}_2/\text{Cl}^-}^\circ = +1.36 \text{ V}$, $E_{\text{Cu}^{2+}/\text{Cu}}^\circ = +0.34 \text{ V}$
 Also calculate standard free energy change and equilibrium constant of the reaction.
 (b) The emf of a galvanic cell composed of two hydrogen electrodes is 0.16 volt at 25 °C. Calculate pH of the anode solution if the cathode is in a solution with pH = 1.

OR

- (a) Calculate the cell emf and ΔG° for the cell reaction at 25 °C for the cell :
 $\text{Zn}_{(s)} | \text{Zn}^{2+} (0.0004 \text{ M}) || \text{Cd}^{2+} (0.2 \text{ M}) | \text{Cd}_{(s)}$
 E° values at 25°C : $\text{Zn}^{2+}/\text{Zn} = -0.763 \text{ V}$;
 $\text{Cd}^{2+}/\text{Cd} = -0.403 \text{ V}$; $F = 96500 \text{ C mol}^{-1}$;
 $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$.
 (b) If E° for copper electrode is 0.34 V, how will you calculate its emf value when the solution in contact with it is 0.1 M in copper ions? How does emf for copper electrode change when concentration of Cu^{2+} ions in the solution is decreased?
 32. (a) Equivalent conductance of a 0.0128 N solution of acetic acid is 1.4 $\text{mho cm}^2 \text{ eq}^{-1}$ and conductance at infinite dilution is

391 $\text{mho cm}^2 \text{ eq}^{-1}$. Calculate degree of dissociation and dissociation constant of acetic acid.

- (b) The equivalent conductances of sodium acetate, sodium chloride and hydrochloric acid are 83, 127 and 426 $\text{mho cm}^2 \text{ eq}^{-1}$ at 250°C respectively. Calculate the equivalent conductance of acetic acid solution.

OR

- (a) Calculate the molar conductivity of NH_4OH at infinite dilution, if molar conductivity at infinite dilution for $\text{Ba}(\text{OH})_2$, BaCl_2 and NH_4Cl are 523.28, 280.0 and 129.8 $\text{S cm}^2 \text{ mol}^{-1}$ respectively.
 (b) How long has a current of 3 A to be applied through a solution of silver nitrate to coat a metal surface of 80 cm^2 with 0.005 mm thick layer? Density of silver is 10.5 g/cm^3 .
 33. (i) On passing equal amount of charge, 11.2 L of Cl_2 was liberated at STP from NaCl solution whereas 9.88 g of metal was deposited from a nitrate solution of this metal. If the specific heat of metal is 0.216 cal/g, what is the formula of metal nitrate?
 (ii) A steady current was passed for 5 hours through two cells connected in series. First cell contains a solution of AuCl_3 and second contains CuSO_4 solution. 9.85 g of gold was deposited in the first cell. Find the amount of Cu deposited in the second cell. Also calculate the magnitude of current in ampere.

OR

Molten aluminium chloride is electrolysed with a current of 0.5 A to produce 27.0 g of aluminium.

- (i) How many gram equivalent of aluminium were produced?
 (ii) How many gram atoms of aluminium were produced?
 (iii) How many atoms of aluminium were produced?
 (iv) How many electrons were involved?
 (v) What is the number of Faraday of electricity consumed?

[At. wt. of Al = 27, Avogadro no. = 6.02×10^{23}]

SOLUTIONS

1. (i)(b)

$$(ii) (c) : \alpha = \frac{\Lambda_c}{\Lambda^\infty} \Rightarrow 0.1 = \frac{\Lambda_c}{279} \Rightarrow \Lambda_c = 27.9$$

OR

(d) : The ions formed are Li^+ , Na^+ and K^+ , the hydration is maximum in case of Li^+ because of which its mobility is least and has least conductance.

Therefore, the correct order is $\text{KCl} > \text{NaCl} > \text{LiCl}$.

(iii)(a)

$$\begin{aligned} (iv) (c) : \Lambda_{m(\text{CaCl}_2)}^\circ &= \lambda_{\text{Ca}^{2+}}^\circ + 2\lambda_{\text{Cl}^-}^\circ \\ &= (118.88 \times 10^{-4}) + 2(77.33 \times 10^{-4}) \\ &= 273.54 \times 10^{-4} \text{ m}^2 \text{ mho mol}^{-1} \end{aligned}$$

2. (i)(b)

(ii) (a)

OR

(a) : More negative is the standard reduction potential, greater is its ability to displace hydrogen from acid.

(iii)(d) : A negative value of standard reduction potential means that oxidation takes place on the electrode with reference to SHE.

(iv) (a)

3. (a) : According to electrochemical series, the increasing order of strength of reducing agent is $\text{Ag} < \text{Cu} < \text{Fe} < \text{Zn}$. As higher the reducing strength higher will be its tendency to release electrons. Hence, the increasing order for electron releasing tendency is $\text{Ag} < \text{Cu} < \text{Fe} < \text{Zn}$.

4. (b) : Higher the oxidation potential, more easily it is oxidised and hence greater is the reducing power. Hence, increasing order of reducing power is $\text{Ag} < \text{Cr} < \text{Mg} < \text{K}$.

OR

(d) : Lower the reduction potential, higher will be the reducing power.

$$\begin{aligned} 5. (b) : E_{\text{cell}}^\circ &= E_{\text{Ag}_2\text{O}/\text{Ag}}^\circ - E_{\text{Zn}^{2+}/\text{Zn}}^\circ \\ &= 0.344 - (-0.76) = 1.104 \text{ V} \\ \Delta G^\circ &= -nFE_{\text{cell}}^\circ = -2 \times 96500 \times 1.104 \\ &= -2.13 \times 10^5 \text{ J mol}^{-1} \end{aligned}$$

6. (b) : The standard Gibbs' energy

$$(\Delta G^\circ) = -nFE_{\text{cell}}^\circ; \text{ Value of } n = 2$$

$$\therefore \Delta G^\circ = -2 \times 96500 \times 0.24 = -46320 \text{ J} = -46.32 \text{ kJ/mol}$$

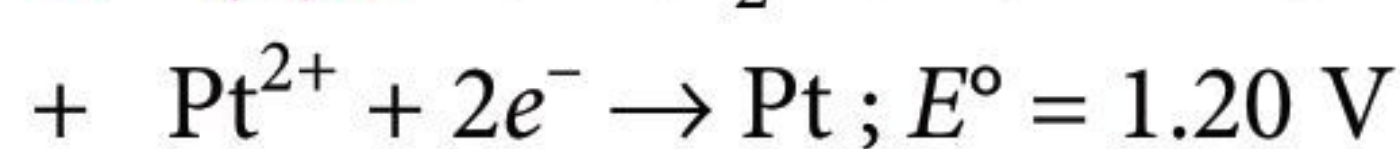
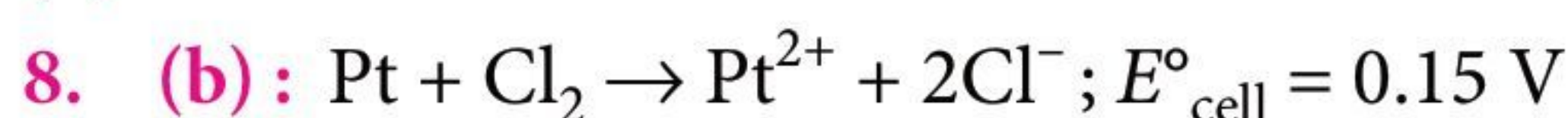
OR

(c)

7. (c) : Specific conductance = S m^{-1}

OR

(d)



OR

(c)

9. (d) : The electrode at which electrons are lost is called anode.

10. (c)

11. (d)

12. (c) : The cell constant depends upon the distance between the electrodes and their area of cross section.

13. (d) : Electrolysis of brine solution ($\text{NaCl}_{(aq)}$) produces NaOH , H_2 and Cl_2 .

Hydrogen gas is obtained at cathode.

14. (b) : KCl , NaCl and NH_4Cl cannot be used as salt bridge in a cell containing silver as one of the electrodes because they react to form a precipitate of AgCl .

OR

(b) : In the plot of molar conductivity versus concentration, for weak electrolyte the extrapolation to zero concentration is not possible.

15. (a) : The conductance is the property of the conductor which facilitates the flow of electricity through it however resistance resists the flow of electricity.

16. (d) : Dry air has no action on pure iron. Rust has the composition $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$.

17. (i) Because fluorine has highest reduction potential.

(ii) Lithium metal is strongest reducing agent because Li has lowest reduction potential i.e., $E_{\text{Li}^+/\text{Li}}^\circ = -3.05 \text{ V}$

OR

(i) Electrolyte A is a strong electrolyte while electrolyte B is a weak electrolyte.

(ii) For electrolyte A, the plot becomes linear near high dilution and thus can be extrapolated to zero concentration to get the molar conductivity at infinite dilution.

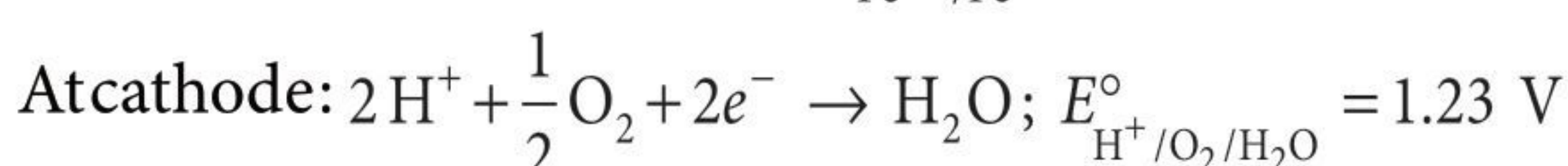
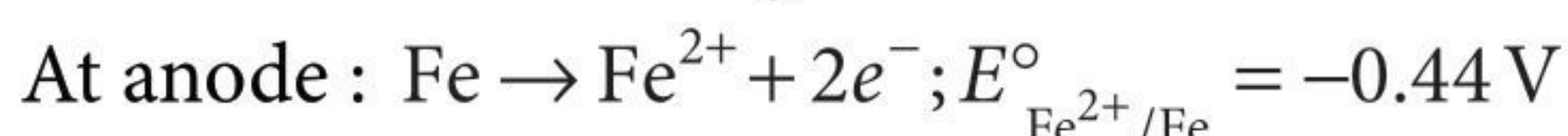
For weak electrolyte B, Λ_m increases steeply on dilution and extrapolation to zero concentration is not possible. Hence, molar conductivity at infinite dilution cannot be determined.

$$18. \text{ We know, } \Lambda_{eq} = \kappa \times \frac{1000}{\text{Normality}}$$

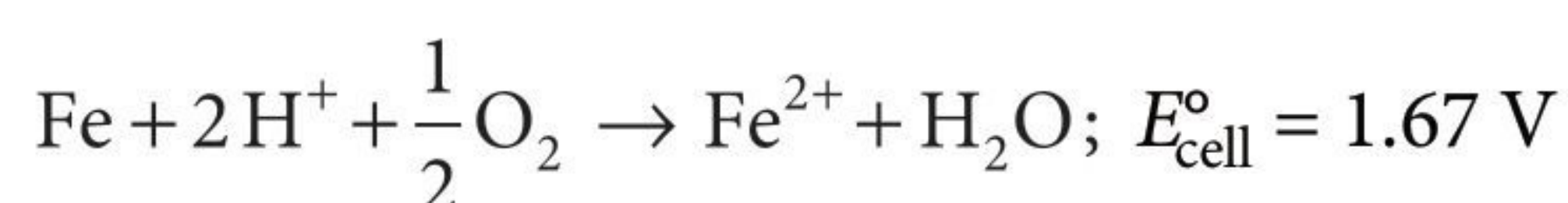
$$\text{i.e., } \kappa = \frac{105.5 \times 0.25}{1000} \text{ but } \kappa = \frac{1}{R} \times \frac{l}{a}$$

$$\text{also } R = \frac{1}{\kappa} \times \frac{l}{a} = \frac{1000}{105.5 \times 0.25} \times \frac{1.9}{3.6} = 20 \text{ ohm}$$

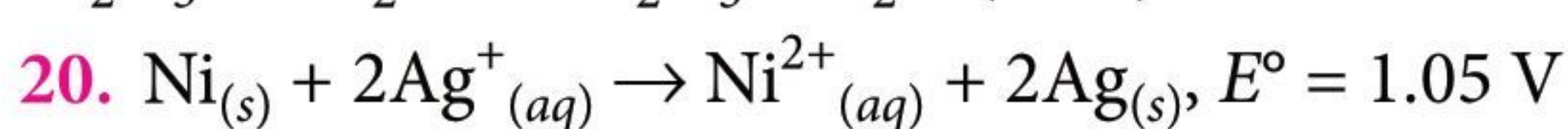
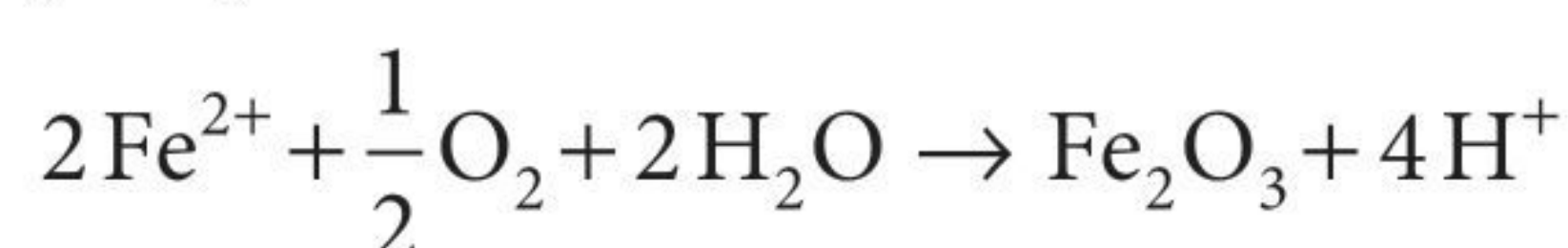
19. The reactions are given below.



Overall reaction :



The Fe^{2+} ions are further oxidised by atmospheric oxygen to Fe^{3+} ions, which form hydrated ferric oxide (rust).



Here, $n = 2$

$$\text{Using formula, } \log K_c = \frac{nE_{\text{cell}}^\circ}{0.059}$$

$$\text{or } \log K_c = \frac{2 \times 1.05}{0.059} = 35.5932$$

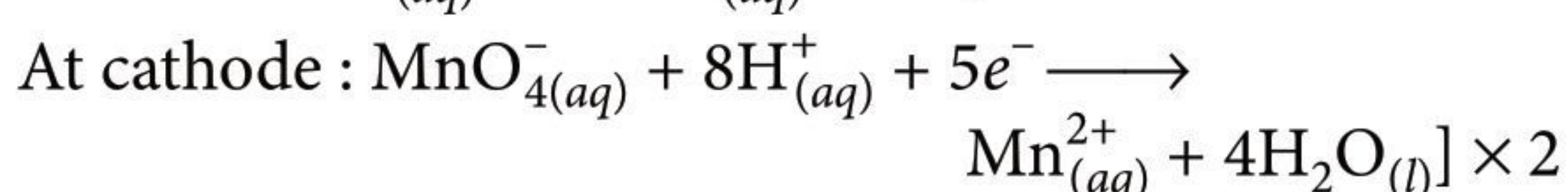
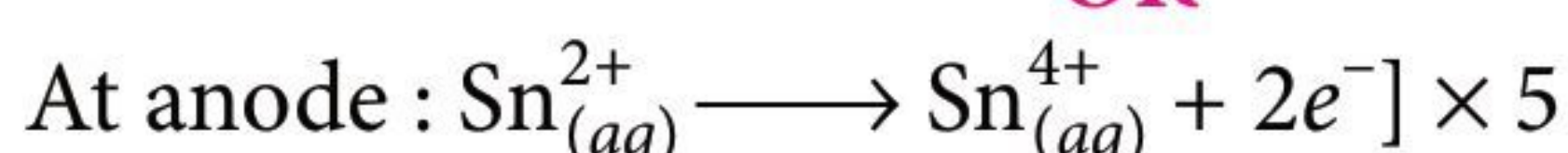
$$K_c = \text{antilog } 35.5932 \text{ or } K_c = 3.92 \times 10^{35}$$

$$\text{Again, } \Delta G^\circ = -nFE_{\text{cell}}^\circ$$

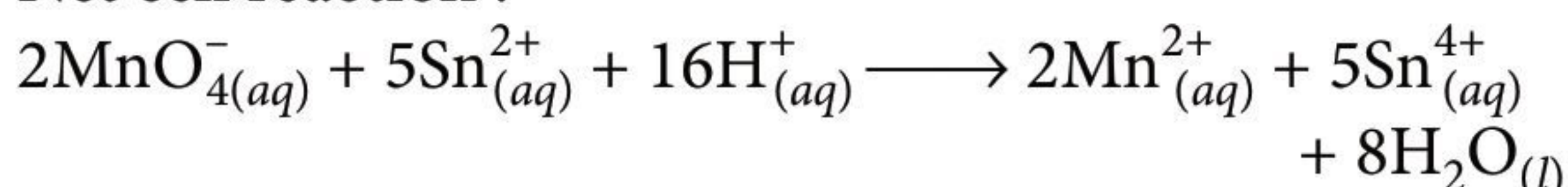
$$\Delta G^\circ = -2 \times 96500 \times 1.05 = -202650 \text{ J mol}^{-1}$$

$$\Delta G^\circ = -202.65 \text{ kJ mol}^{-1}$$

OR



Net cell reaction :



$$E_{\text{cell}}^\circ = E_{\text{cathode}}^\circ - E_{\text{anode}}^\circ = 1.51 \text{ V} - 0.15 \text{ V} = 1.36 \text{ V}$$

Since, cell potential is positive therefore the reaction is product favoured.

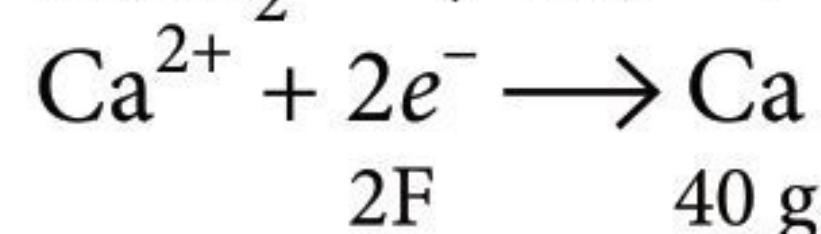
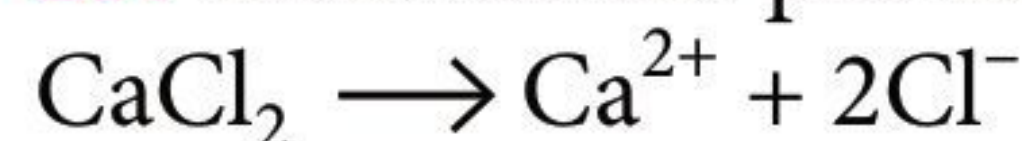
21. The limiting molar conductivity of an electrolyte is defined as its molar conductivity when the concentration of the electrolyte in the solution approaches zero.

Conductivity of an electrolyte decreases with dilution because the number of current carrying particles *i.e.*, ions present per cm^3 of the solution becomes less and less on dilution.

22. With time, concentrations of the electrolytic solutions change. Hence, their electrode potentials

change when the electrode potentials of the two half-cells become equal, the cell stops working.

23. Reaction for production of Ca from molten CaCl_2 :



2F 40 g

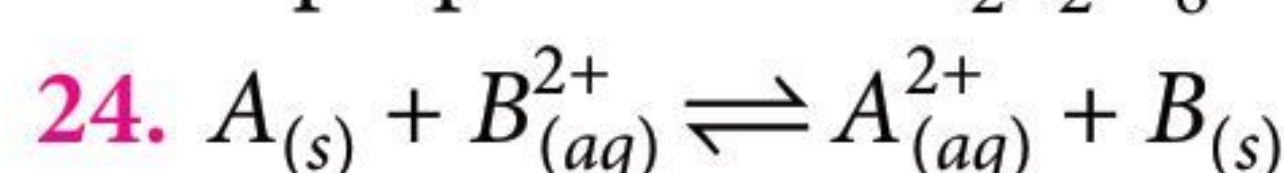
Electricity required to produce 40 g = 2 F

\therefore Electricity required to produce 20 g

$$= 0.5 \times 2 \text{ F} = 1 \text{ F}$$

OR

Hydrogen gas is released at cathode. At anode, oxidation of OH^- ions from water take place and O_2 is obtained. At higher concentration of H_2SO_4 , oxidation of SO_4^{2-} ion is prepared and $\text{H}_2\text{S}_2\text{O}_8$ is obtained.



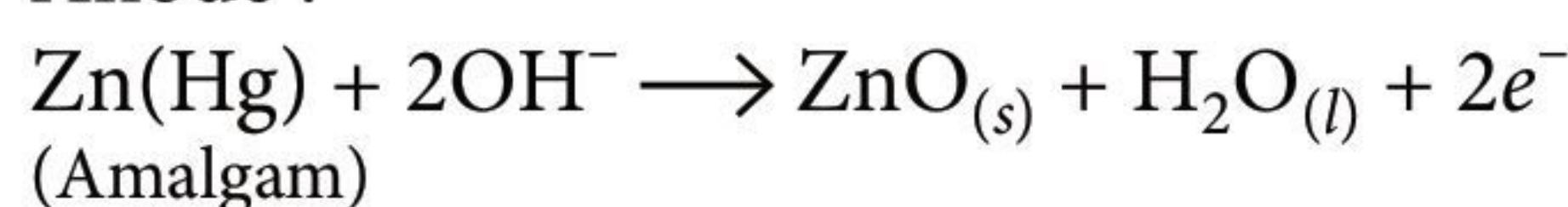
Here, $n = 2$

$$\text{using formula, } E_{\text{cell}}^\circ = \frac{0.059}{n} \log K_c; E_{\text{cell}}^\circ = \frac{0.059}{2} \log 10$$

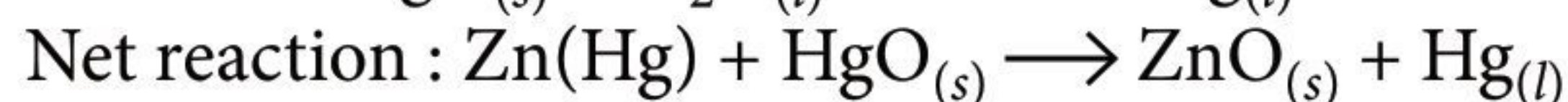
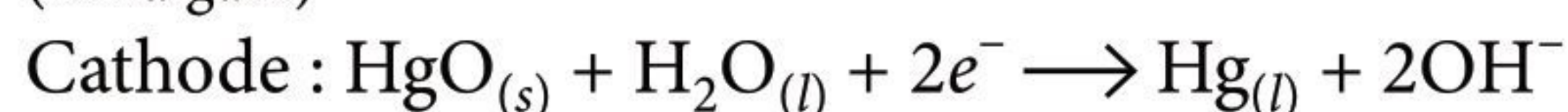
$$E_{\text{cell}}^\circ = 0.0295 \text{ V}$$

25. The cell reactions are as follows :

Anode :



(Amalgam)



The cell potential remains constant during its life as the overall reaction does not involve any ion in solution whose concentration can change during its use.

$$26. \text{(a) Degree of dissociation, } \alpha = \frac{\Lambda_{eq}}{\Lambda_{eq}^\infty}$$

$$\therefore \alpha = \frac{15.8}{350} = 0.04514$$

(b) For monobasic acid, $\text{HA} \rightleftharpoons \text{H}^+ + \text{A}^-$

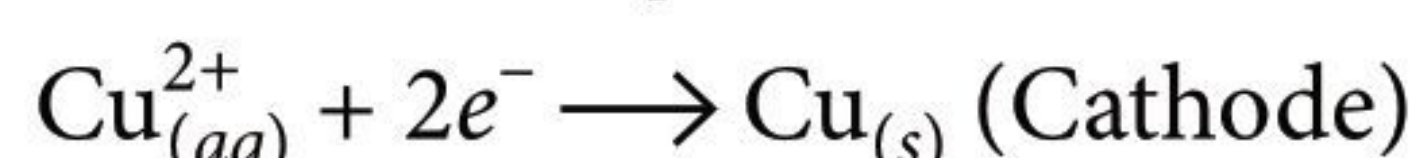
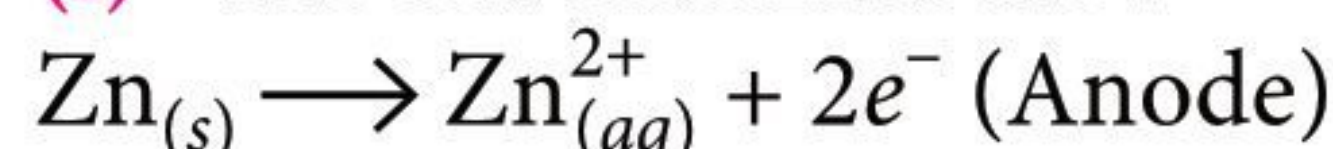
$$K = \frac{C\alpha^2}{(1-\alpha)} = C\alpha^2$$

As $\alpha \ll 1$ hence $(1-\alpha) \approx 1$

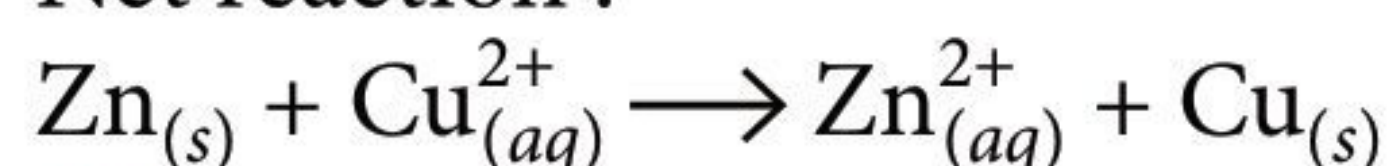
$$\therefore K = 0.05 \times (0.04514)^2, K = 1.019 \times 10^{-4}$$

OR

(i) The cell reactions are :

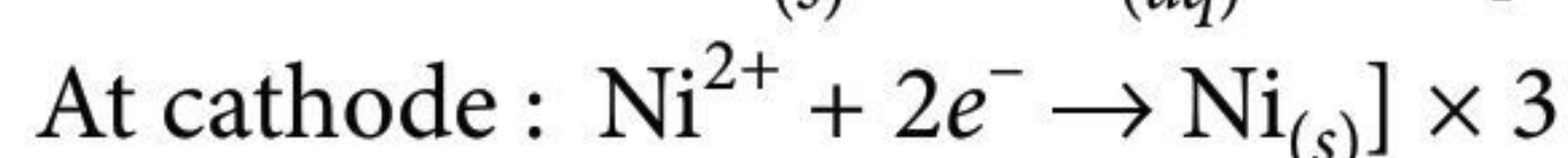
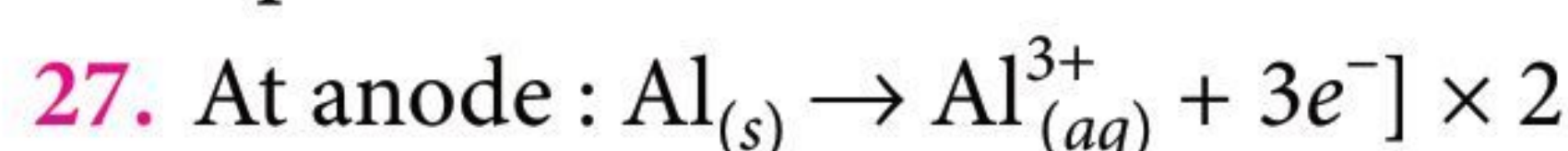


Net reaction :



$$(ii) E_{\text{cell}}^\circ = E_{\text{cathode}}^\circ - E_{\text{anode}}^\circ = 0.34 \text{ V} - (-0.76 \text{ V}) = 1.10 \text{ V}$$

(iii) Copper electrode will be positive at which reduction takes place.



Cell reaction : $2\text{Al}_{(s)} + 3\text{Ni}_{(aq)}^{2+} \rightarrow 2\text{Al}_{(aq)}^{3+} + 3\text{Ni}_{(s)}$

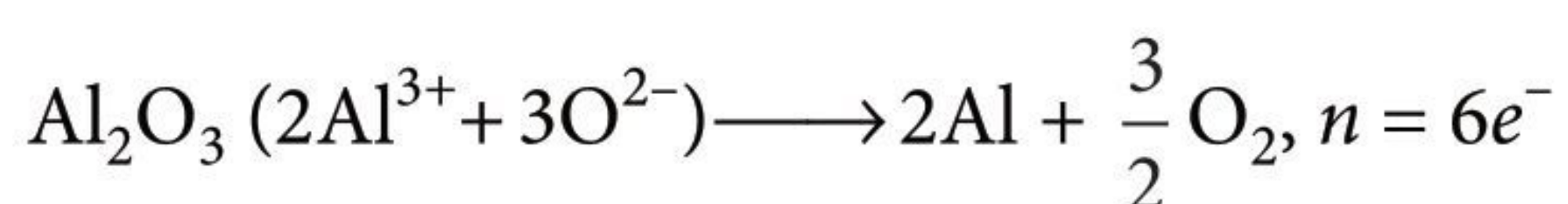
Applying Nernst equation to the above cell reaction,

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{2 \times 3} \log \frac{[\text{Al}^{3+}]^2}{[\text{Ni}^{2+}]^3}$$

$$\text{Now, } E_{\text{cell}}^{\circ} = E_{\text{Ni}^{2+}/\text{Ni}}^{\circ} - E_{\text{Al}^{3+}/\text{Al}}^{\circ} \\ = -0.25 - (-1.66) = 1.41 \text{ V}$$

$$\therefore E_{\text{cell}} = 1.41 - \frac{0.0591}{6} \log \frac{(10^{-3})^2}{(0.5)^3} \\ = 1.41 - \frac{0.0591}{6} \log (8 \times 10^{-6}) = 1.46 \text{ V}$$

OR



$$\Delta G = 960 \times 1000 = 960000 \text{ J}$$

$$\text{Now, } \Delta G = -nFE_{\text{cell}}$$

$$E_{\text{cell}}^{\circ} = -\frac{\Delta G}{nF} = \frac{-960000}{4 \times 96500} = -2.487 \text{ V}$$

Minimum potential difference needed to reduce Al_2O_3 is -2.487 V .

28. Given : $V = 100 \text{ cm}^3$, $M = 0.025 \text{ M}$, $R = 520 \text{ ohm}$
 $G^* = 153.7 \text{ m}^{-1} = 1.537 \text{ cm}^{-1}$, $\Lambda_m = ?$

$$\kappa = G^* \times \frac{1}{R} = 1.537 \text{ cm}^{-1} \times \frac{1}{520 \text{ ohm}} \\ = 2.95 \times 10^{-3} \text{ ohm}^{-1} \text{ cm}^{-1}$$

$$\text{Again, } \Lambda_m = \frac{\kappa \times 10^3}{M} = \frac{2.95 \times 10^{-3} \text{ ohm}^{-1} \text{ cm}^{-1} \times 10^3}{0.025 \text{ mol cm}^{-3}}$$

$$\Lambda_m = 118.0 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

29. $\kappa = 1.29 \times 10^{-2} \text{ ohm}^{-1} \text{ cm}^{-1}$

$$\kappa = \frac{1}{R} \times \text{Cell constant}$$

$$\Rightarrow \text{Cell constant} = \kappa \times R = 1.29 \text{ S m}^{-1} \times 85 \Omega \\ = 109.65 \text{ m}^{-1}$$

For second solution,

$$\kappa = \frac{1}{R} \times \text{Cell constant} = \frac{1}{96 \Omega} \times 109.65 \text{ m}^{-1} \\ = 1.142 \Omega^{-1} \text{ m}^{-1}$$

$$\Lambda_m = \frac{\kappa \times 1000}{M} = \frac{1.142 \Omega^{-1} \text{ m}^{-1} \times 1000 \text{ cm}^3}{0.052} \\ = 219.62 \text{ S cm}^2 \text{ mol}^{-1}$$

30. (a) Molar conductivity of weak electrolytes keeps on increasing with dilution and does not become constant even at very large dilutions. Therefore, Λ_m° for acetic acid cannot be determined experimentally.

(b) Kohlrausch's law states that at infinite dilution, when the dissociation of electrolyte is complete each ion makes a definite contribution towards the molar conductivity of electrolyte, irrespective of the nature of other ion with which it is associated.

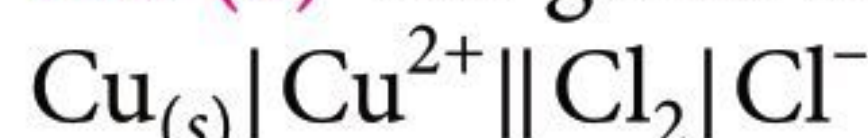
$$\Lambda_m^{\circ} = \nu_+ \lambda_+^{\circ} + \nu_- \lambda_-^{\circ}$$

(c) $\Lambda_{\text{NaKC}_2\text{O}_4}^{\circ} = \lambda_{\text{Na}^+}^{\circ} + \lambda_{\text{K}^+}^{\circ} + \lambda_{\text{C}_2\text{O}_4^{2-}}^{\circ}$
 $= 74.1 + 50.1 + 73.5 = 197.7 \text{ S cm}^2 \text{ mol}^{-1}$
 for NaKC_2O_4 eq. conductivity,

$$(\Lambda^{\circ}) = \frac{\text{molar conductivity}}{n} = \frac{\Lambda_m^{\circ}}{2}$$

$$\therefore \Lambda_{\text{NaKC}_2\text{O}_4}^{\circ} = \frac{197.7}{2} = 98.85 \text{ S cm}^2 \text{ eq}^{-1}$$

31. (a) The given cell may be represented as



$$(i) E_{\text{cell}}^{\circ} = E_c^{\circ} - E_a^{\circ} = (+1.36 \text{ V}) - (+0.34 \text{ V}) = 1.02 \text{ V}$$

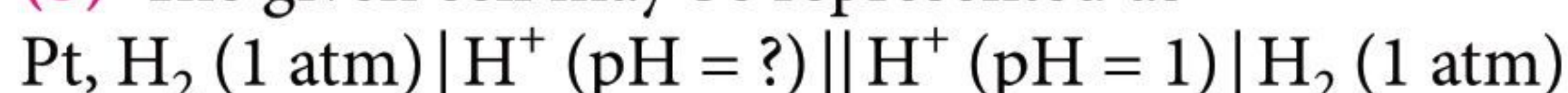
$$(ii) \Delta_r G^{\circ} = -nFE^{\circ} = -2 \times 96500 \text{ C} \times 1.02 \text{ V} = 196.86 \text{ kJ}$$

$$(iii) E_{\text{cell}}^{\circ} = \frac{0.0591}{n} \log K$$

$$K = \text{antilog} \frac{2 \times 1.02}{0.0591} = \text{antilog} (34.51)$$

$$K = 3.236 \times 10^{34}$$

(b) The given cell may be represented as



$$\text{Using formula, } E_{\text{cell}} = \frac{0.0591}{1} \log \frac{[\text{H}^+]_c}{[\text{H}^+]_a}$$

$$\text{or } 0.16 = 0.0591 [\log [\text{H}^+]_c - \log [\text{H}^+]_a]$$

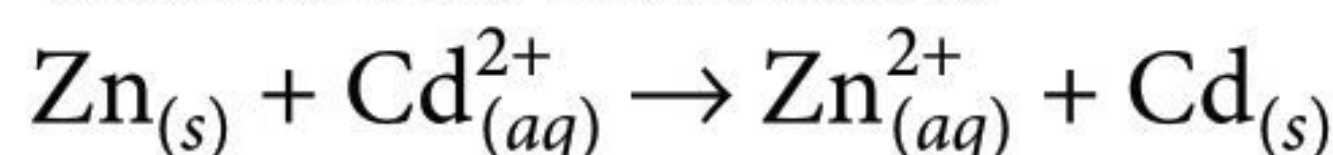
$$\text{or } 0.16 = 0.0591 [\text{pH}_a - \text{pH}_c]; 0.16 = 0.0591 [\text{pH}_a - 1]$$

$$\text{or } \text{pH}_a - 1 = \frac{0.16}{0.0591} = 2.70 \text{ or } \text{pH}_a = 2.70 + 1 = 3.70$$

OR

$$(a) E_{\text{cell}}^{\circ} = E_{\text{cathode}}^{\circ} - E_{\text{anode}}^{\circ} = -0.403 - (-0.763) = 0.36 \text{ V}$$

The net cell reaction is



Here, value of $n = 2$

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{2} \log \frac{[\text{Zn}^{2+}]}{[\text{Cd}^{2+}]} \\ = 0.36 - \frac{0.0591}{2} \log \frac{0.0004}{0.2} = 0.44 \text{ V}$$

$$\therefore \Delta G^{\circ} = -nFE_{\text{cell}}^{\circ} = -2 \times 96500 \times 0.36 = -69480 \text{ J/mol}$$

(b) $\text{Cu}_{(aq)}^{2+} + 2e^{-} \rightarrow \text{Cu}_{(s)}$

$$E_{\text{Cu}^{2+}/\text{Cu}} = E_{\text{Cu}^{2+}/\text{Cu}}^{\circ} - \frac{0.059}{2} \log \frac{[\text{Cu}]}{[\text{Cu}^{2+}]}$$

$$= 0.34 - \frac{0.059}{2} \log \frac{1}{0.1} = 0.34 - \frac{0.059}{2} \log 10 = 0.3105 \text{ V}$$

When the concentration of Cu^{2+} ions is decreased, the electrode potential for copper decreases.

32. (a) Given : $\Lambda_{eq} = 1.4 \text{ mho cm}^2 \text{ eq}^{-1}$,
 $\Lambda_{eq}^\infty = 391 \text{ mho cm}^2 \text{ eq}^{-1}$, $\alpha = ?$, $K_a = ?$

$$\text{Using formula, } \alpha = \frac{\Lambda_{eq}}{\Lambda_{eq}^\infty} = \frac{1.4 \text{ mho cm}^2 \text{ eq}^{-1}}{391 \text{ mho cm}^2 \text{ eq}^{-1}} = 0.00358$$

$$K_a = \frac{\alpha^2 C}{1 - \alpha} = \frac{(0.00358)^2 \times 0.0128}{1 - 0.00358} = \frac{1.64 \times 10^{-7}}{0.99642} = 1.64 \times 10^{-7}$$

(b) Given : $\Lambda_{eq}^\circ (\text{CH}_3\text{COONa}) = 83 \text{ mho cm}^2 \text{ eq}^{-1}$
 $\Lambda_{eq}^\circ (\text{NaCl}) = 127 \text{ mho cm}^2 \text{ eq}^{-1}$
 $\Lambda_{eq}^\circ (\text{HCl}) = 426 \text{ mho cm}^2 \text{ eq}^{-1}$
 $\Lambda_{eq}^\circ (\text{CH}_3\text{COOH}) = ?$

Using Kohlrausch law of independent migration of ions
 $\Lambda_{eq}^\circ (\text{CH}_3\text{COOH}) = \Lambda_{eq}^\circ (\text{CH}_3\text{COONa}) + \Lambda_{eq}^\circ (\text{HCl}) - \Lambda_{eq}^\circ (\text{NaCl})$

$$\text{or } \Lambda_{eq}^\circ (\text{CH}_3\text{COOH}) = 83 + 426 - 127 = 382 \text{ mho cm}^2 \text{ eq}^{-1}$$

OR

(a) Given, $\Lambda_{\text{Ba}(\text{OH})_2}^\circ = \lambda_{\text{Ba}^{2+}}^\circ + 2\lambda_{\text{OH}^-}^\circ = 523.28 \quad \dots\text{(i)}$

$\Lambda_{\text{BaCl}_2}^\circ = \lambda_{\text{Ba}^{2+}}^\circ + 2\lambda_{\text{Cl}^-}^\circ = 280.0 \quad \dots\text{(ii)}$

$\Lambda_{\text{NH}_4\text{Cl}}^\circ = \lambda_{\text{NH}_4^+}^\circ + \lambda_{\text{Cl}^-}^\circ = 129.8 \quad \dots\text{(iii)}$

$$\Lambda_{\text{NH}_4\text{OH}}^\circ = \frac{\Lambda_{\text{Ba}(\text{OH})_2}^\circ + 2\Lambda_{\text{NH}_4\text{Cl}}^\circ - \Lambda_{\text{BaCl}_2}^\circ}{2} = \frac{523.28 + 2(129.8) - 280.0}{2} = 251.44 \text{ S cm}^2 \text{ mol}^{-1}$$

(b) Mass of silver to be deposited

= Volume \times density

= Area \times thickness \times density

Given : Area = 80 cm^2 , thickness = 0.0005 cm and density = 10.5 g/cm^3

$$\text{Mass of silver to be deposited} = 80 \times 0.0005 \times 10.5 = 0.42 \text{ g}$$

Applying to silver $E = Z \times 96500$

$$Z = \frac{108}{96500} \text{ g}$$

Let the current be passed for t seconds.

We know that, $W = Z \times I \times t$

$$\text{So, } 0.42 = \frac{108}{96500} \times 3 \times t; t = \frac{0.42 \times 96500}{108 \times 3} = 125.09 \text{ s}$$

33. (i) At. wt. of metal = $\frac{6.4}{\text{Sp. heat}} = \frac{6.4}{0.216} = 29.63$

$$\text{Applying, } \frac{W_m}{W_{\text{Cl}_2}} = \frac{E_m}{E_{\text{Cl}_2}}$$

Wt. of 22.4 L of Cl_2 at STP = 71 g

$$\therefore \text{Wt. of } 11.2 \text{ L of } \text{Cl}_2 \text{ at STP} = \frac{71}{22.4} \times 11.2 = 35.5 \text{ g}$$

$$\text{Eq. wt. of } \text{Cl}_2 = \frac{71}{2} = 35.5 \text{ g}$$

$$\text{Eq. wt. of metal} = \frac{\text{At. wt.}}{\text{Valency}} = \frac{29.63}{n}$$

$$n = \frac{29.63}{35.5} \times \frac{35.5}{9.88} = 2.99 \approx 3 \text{ i.e., Metal valency} = 3$$

Hence, metal nitrate must be $M(\text{NO}_3)_3$.

(ii) Given : $W_1 = 9.85 \text{ g Au}$ from AuCl_3

$W_2 = ?$ for Cu from CuSO_4

$$E_1 = \frac{197}{3}, E_2 = \frac{63.5}{2}$$

Using formula, $\frac{W_1}{E_1} = \frac{W_2}{E_2}$

$$\text{or, } W_2 = \frac{9.85 \times 3 \times 63.5}{197 \times 2} = 4.76 \text{ g}$$

Again, 197 g Au requires $3 \times 96500 \text{ C}$ electricity

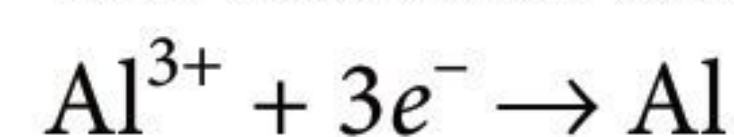
$$\therefore 9.85 \text{ g Au requires } \frac{3 \times 96500 \text{ C}}{197 \text{ g}} \times 9.85 = 14475 \text{ C}$$

Again, $Q = I \cdot t$

$$\therefore I = \frac{Q}{t} = \frac{14475}{5 \times 60 \times 60} = 0.80 \text{ amp}$$

OR

(i) The reaction taking place at cathode is



$$\therefore \text{Gram equivalent of Al} = \frac{\text{Atomic weight}}{3} = \frac{27}{3} = 9 \text{ g}$$

Thus 9 g of $\text{Al} = 1 \text{ g equivalent of Al}$

$$27 \text{ g of Al} = \frac{1}{9} \times 27 = 3 = 3 \text{ g equivalent of Al}$$

(ii) Since atomic weight of $\text{Al} = 27$,

$\therefore 27 \text{ g of Al} = 1 \text{ g atom of aluminium}$

(iii) Since number of atoms in 1 g atom of an element = 6.023×10^{23}

$$\text{Number of atoms of Al produced} = 6.023 \times 10^{23}$$

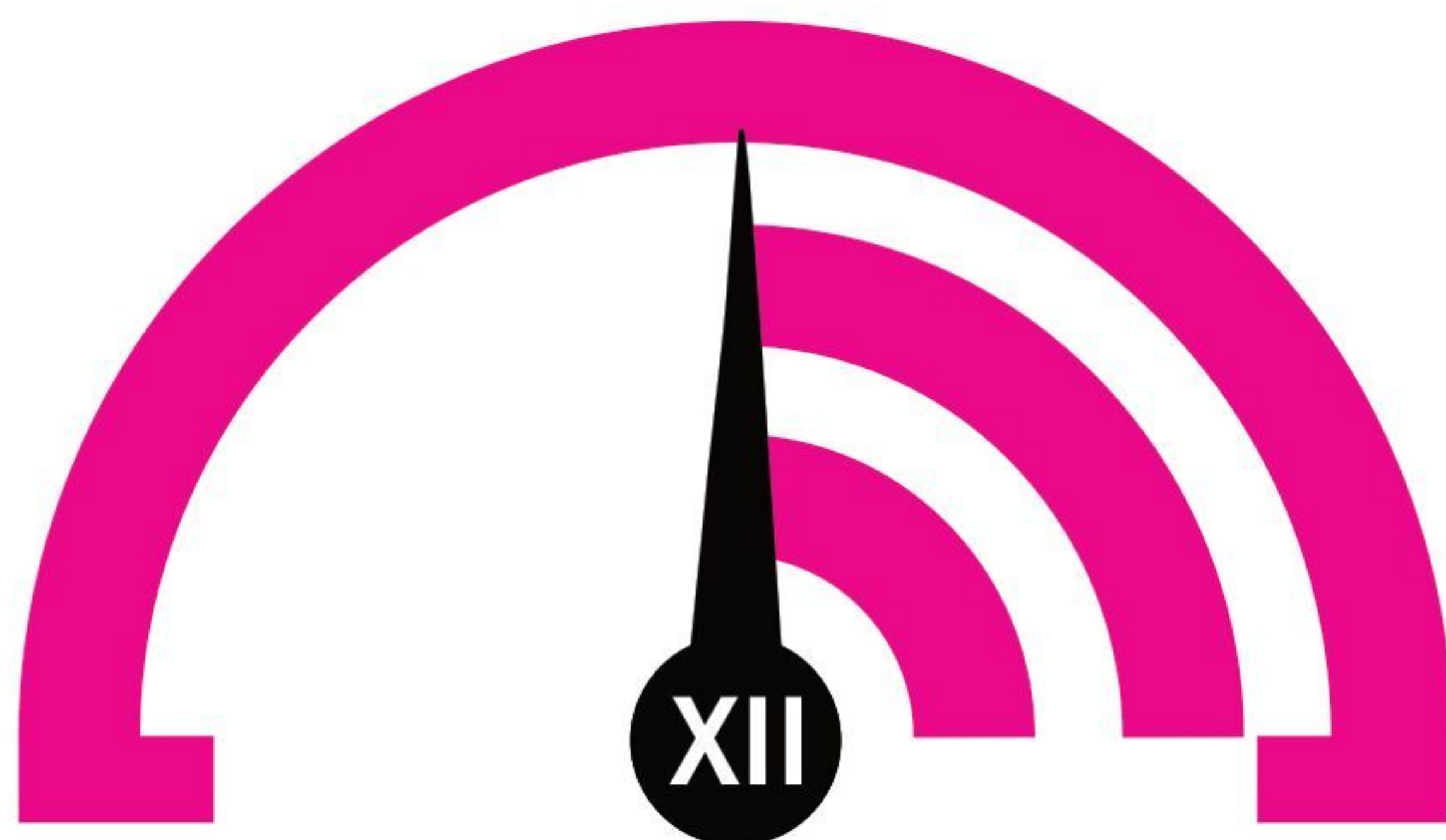
(iv) In the formation of an Al atom, three electrons are taken up by Al^{3+}

$$\therefore \text{Total number of electrons involved} = 3 \times 6.023 \times 10^{23} = 18.069 \times 10^{23}$$

(v) Since $1 \text{ g equivalent of Al}$ is liberated by 1 F , $3 \text{ g equivalent of Al} = 3 \text{ F}$ of electricity.



MONTHLY TEST DRIVE



This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120

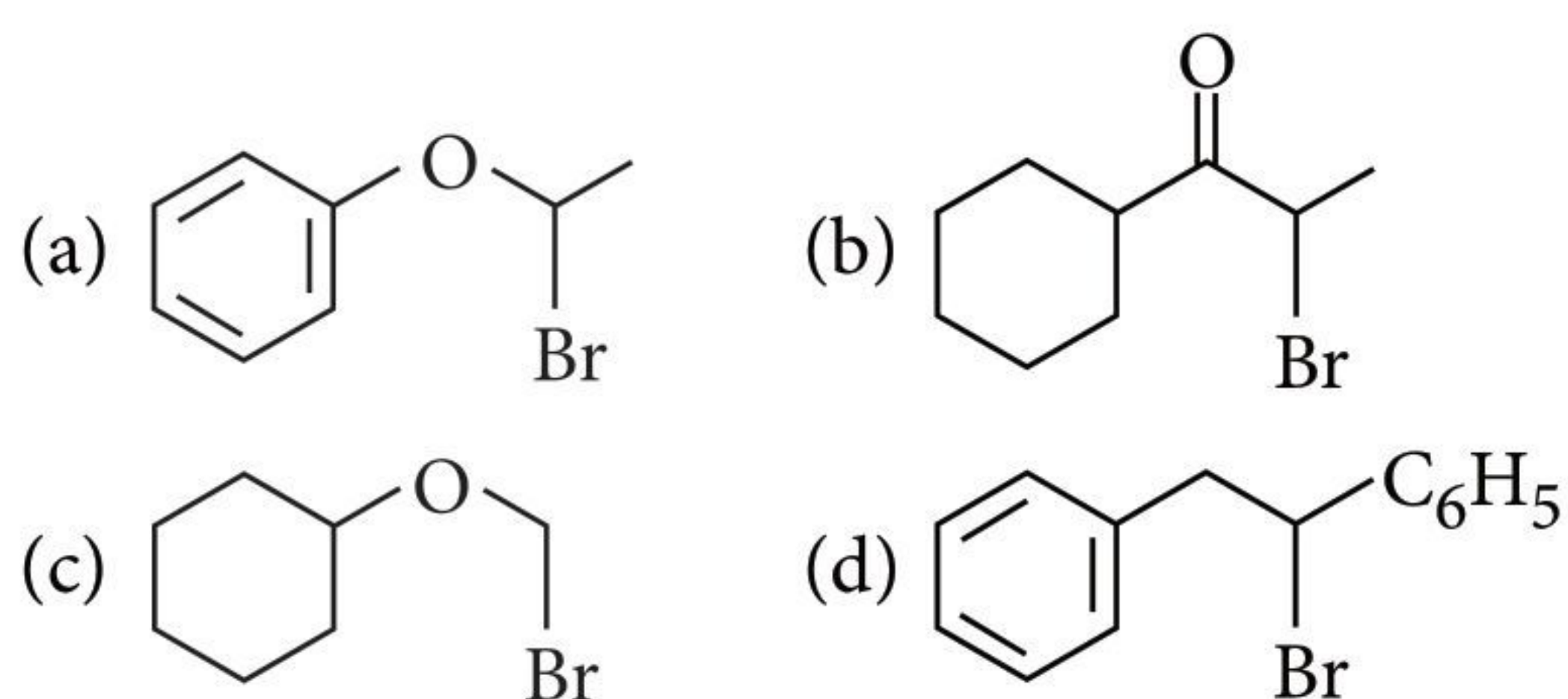
Haloalkanes and Haloarenes | Alcohols, Phenols and Ethers

Time Taken : 60 Min.

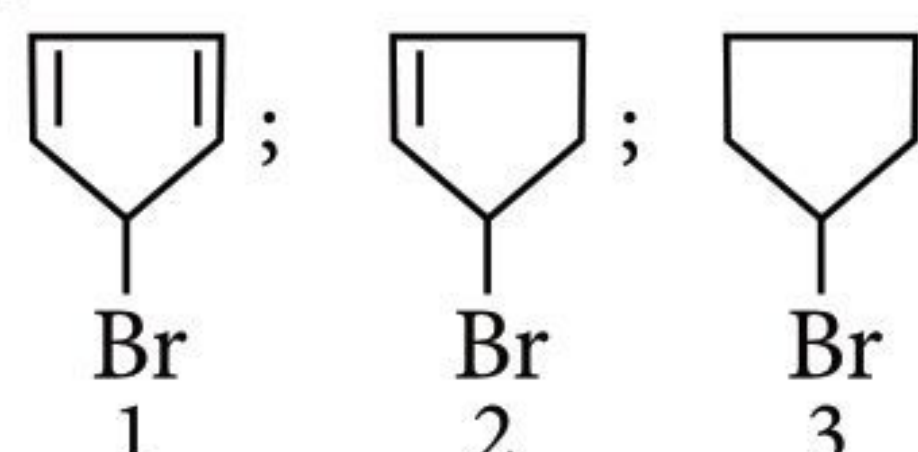
NEET

Only One Option Correct Type

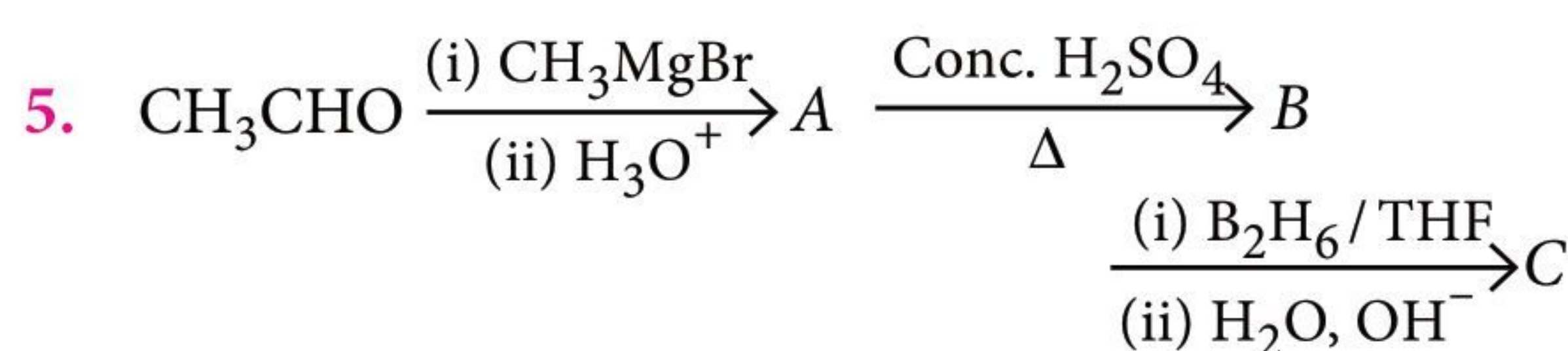
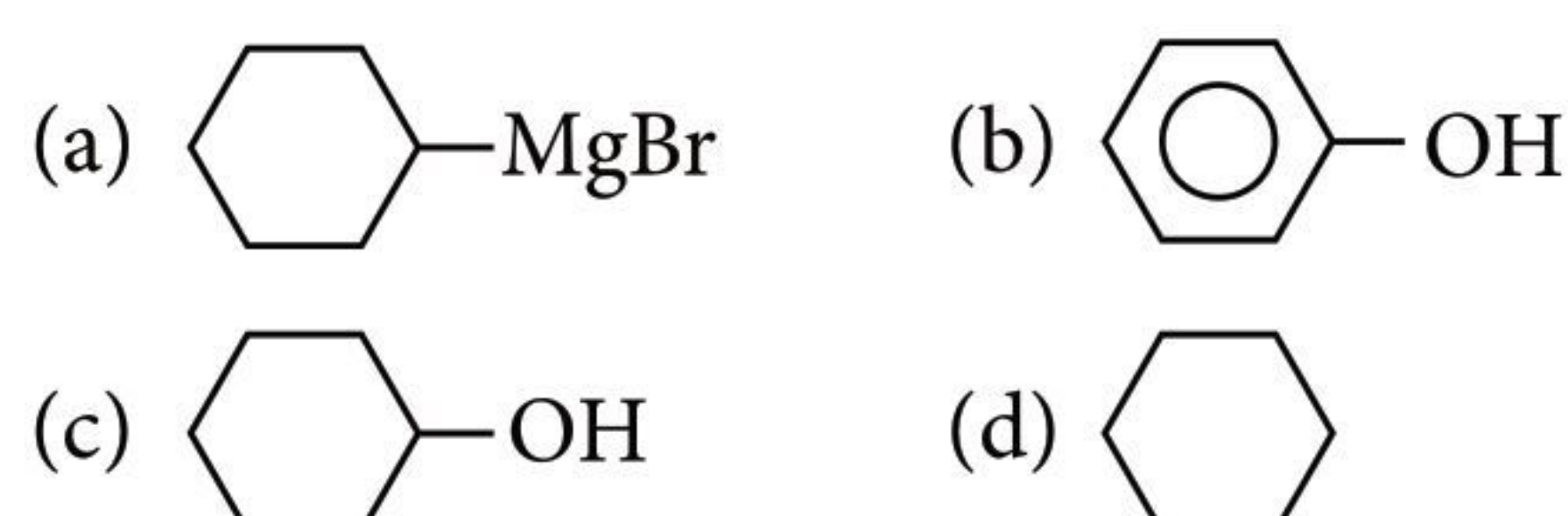
- An incorrect statement with respect to S_N1 and S_N2 mechanisms for alkyl halide is
 - a strong nucleophile in an aprotic solvent increases the rate or favours S_N2 reaction
 - rearrangement is observed in S_N2 reaction
 - S_N1 reactions can be catalysed by some Lewis acids
 - inversion is slightly greater than retention in S_N1 reaction.
- Which of the following, upon treatment with *tert*-BuONa followed by addition of bromine water, fails to decolourise the colour of bromine?



- The decreasing order of rate of S_N1 reaction in the following compounds will be



- (a) $3 > 2 > 1$ (b) $1 > 2 > 3$
 (c) $1 > 3 > 2$ (d) $2 > 3 > 1$
- $\text{Br} + \text{Mg} \xrightarrow{\text{Dry ether}} \text{A} \xrightarrow[\text{H}^+]{\text{H}_2\text{O}} \text{B}$
 The product 'B' is



A and C are

- (a) identical (b) position isomers
 (c) functional isomers (d) optical isomers.
- How many metameric ethers are represented by the molecular formula $\text{C}_4\text{H}_{10}\text{O}$?
 (a) 4 (b) 3 (c) 2 (d) 5
 - Arrange the following compounds in the increasing order of their acidic strengths :
 (i) *m*-Nitrophenol (ii) *m*-Cresol
 (iii) Phenol (iv) *m*-Chlorophenol
 (a) $\text{ii} < \text{iv} < \text{iii} < \text{i}$ (b) $\text{ii} < \text{iii} < \text{i} < \text{iv}$
 (c) $\text{iii} < \text{ii} < \text{i} < \text{iv}$ (d) $\text{ii} < \text{iii} < \text{iv} < \text{i}$
 - The correct sequence of reactions to be performed to convert benzene into *m*-bromoaniline is
 (a) nitration, reduction, bromination
 (b) bromination, nitration, reduction
 (c) nitration, bromination, reduction
 (d) reduction, nitration, bromination.
 - One mole of compound A, on heating with excess of conc. HI gave two moles of ethyl iodide. Compound A is
 (a) ethoxybenzene (b) 1, 2-dimethoxyethane
 (c) methoxyethane (d) ethoxyethane.

10. The strongest base among the following is
 (a) NH_2^- (b) OH^-
 (c) $\text{CH}\equiv\text{C}^-$ (d) CH_3CH_2^-
11. Which of the following compounds would not react with Lucas reagent at room temperature?
 (a) $\text{H}_2\text{C}=\text{CHCH}_2\text{OH}$ (b) $\text{C}_6\text{H}_5\text{CH}_2\text{OH}$
 (c) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (d) $(\text{CH}_3)_3\text{COH}$
12. 2-bromobutane reacts with OH^- in H_2O to give butan-2-ol. The reaction involves
 (a) retention in configuration
 (b) inversion in configuration
 (c) racemisation (d) mutarotation.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

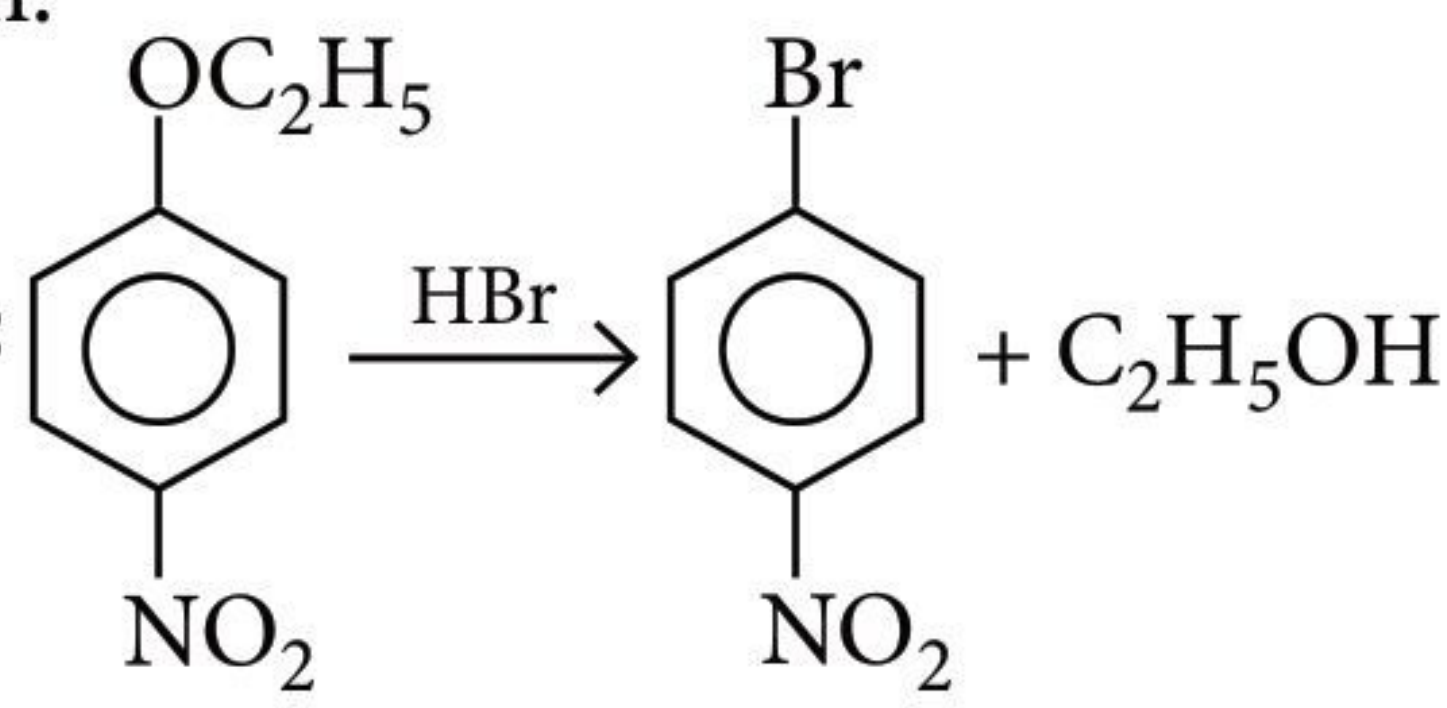
- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
 (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
 (c) If assertion is true but reason is false.
 (d) If both assertion and reason are false.

13. **Assertion :** 1, 2-dichloroethane is optically active.

Reason : Meso compound is optically active.

14. **Assertion :** $\text{CH}_3 - \underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}} - \text{CH}_2 - \text{Br} + \text{NaOH} \longrightarrow \text{CH}_3 - \underset{\text{OH}}{\overset{\text{CH}_3}{\text{C}}} - \text{CH}_2 - \text{CH}_3$

Reason : It follows with formation of more stable carbocation.

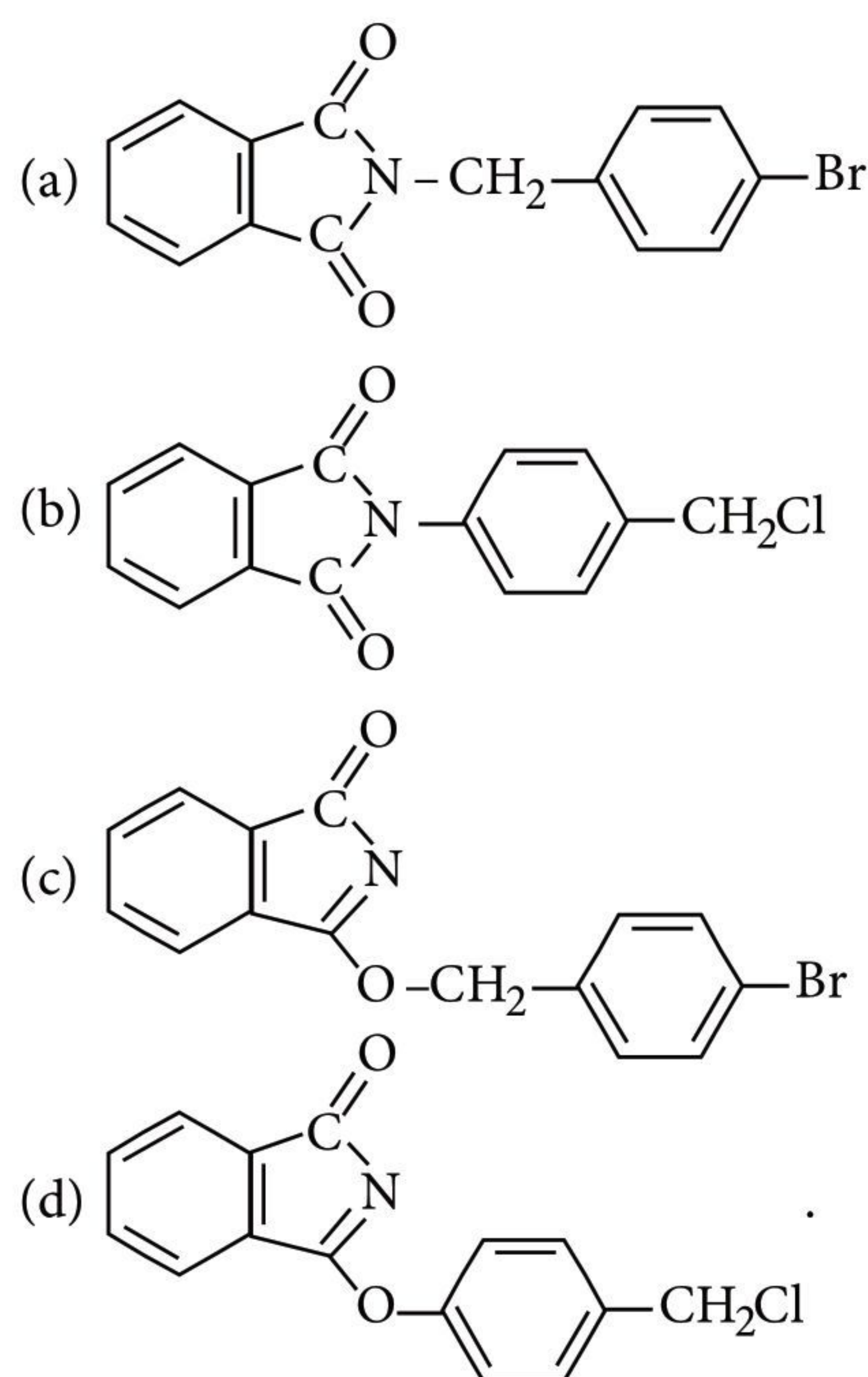
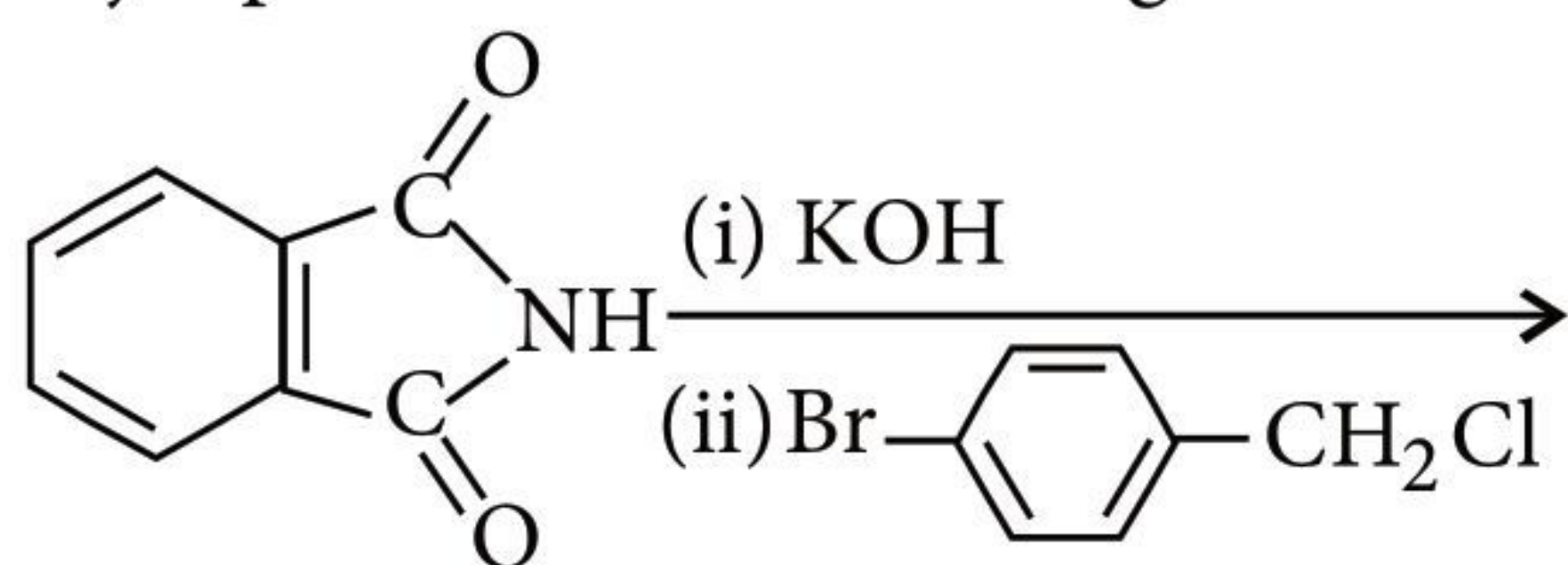
15. **Assertion :** 
 p-Nitroethoxybenzene

Reason : Alkyl aryl ethers on reaction with halogen acid always form aryl halide due to formation of highly stable carbocation.

JEE MAIN / JEE ADVANCED

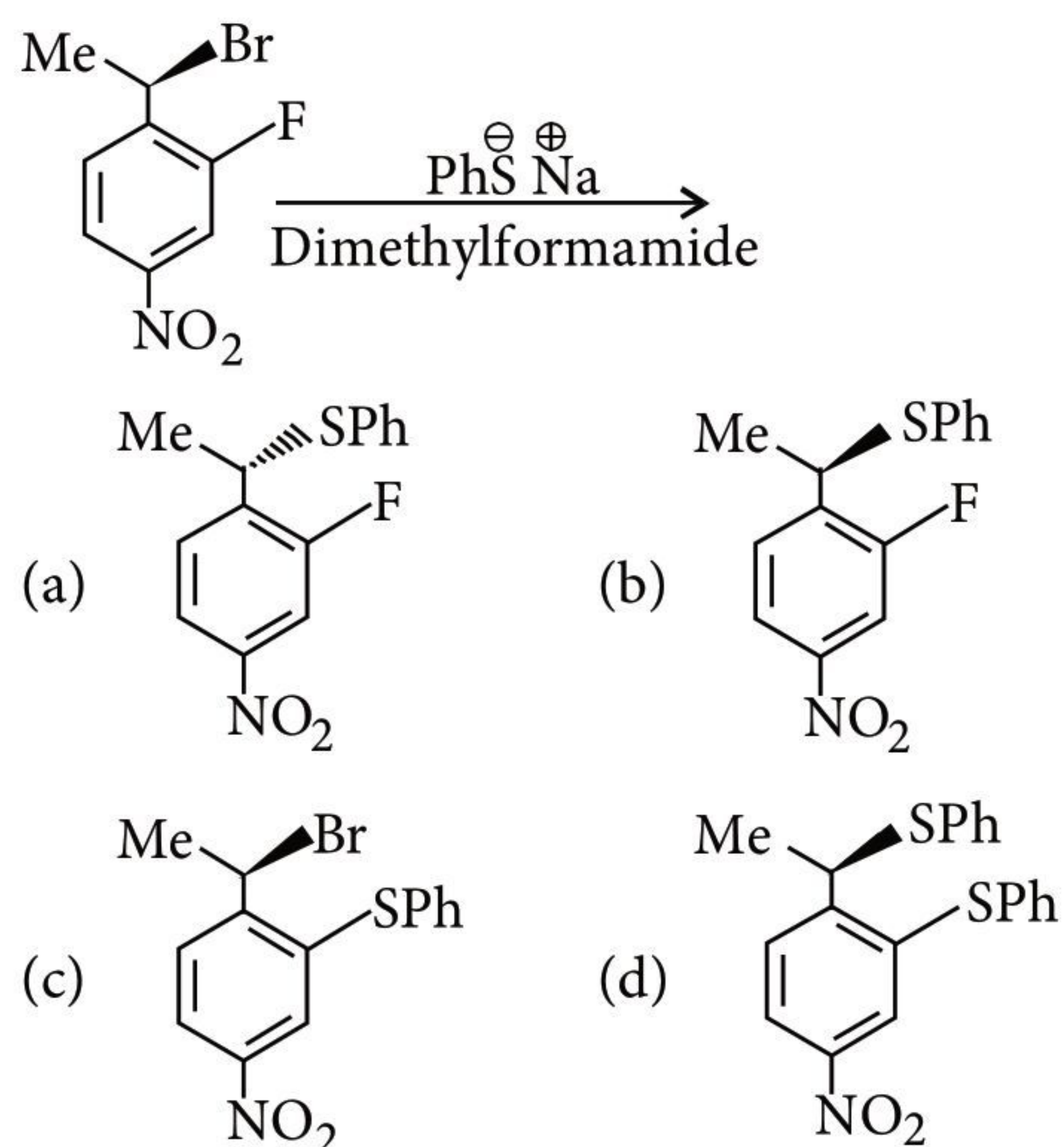
Only One Option Correct Type

16. The major product of the following reaction is



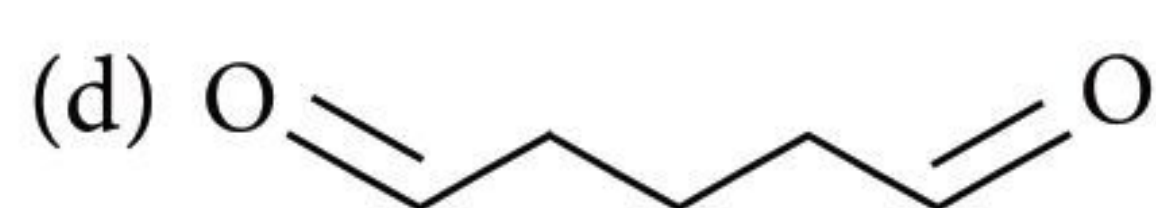
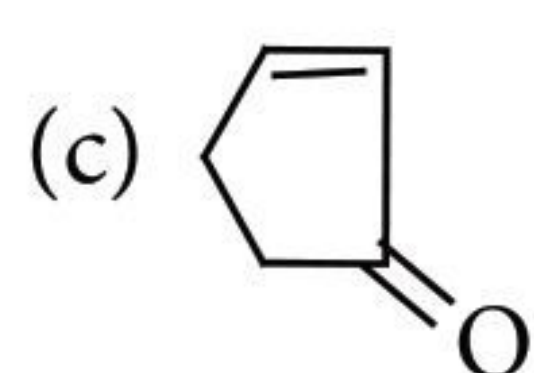
17. What happens when chloroform is left open in air in the presence of sunlight?
 (a) Explosion takes place
 (b) Phosgene, a poisonous gas is formed
 (c) Polymerisation takes place
 (d) No reaction takes place.

18. The major product of the following reaction is



19. Periodic oxidation of 1,2-cyclopentanediol is



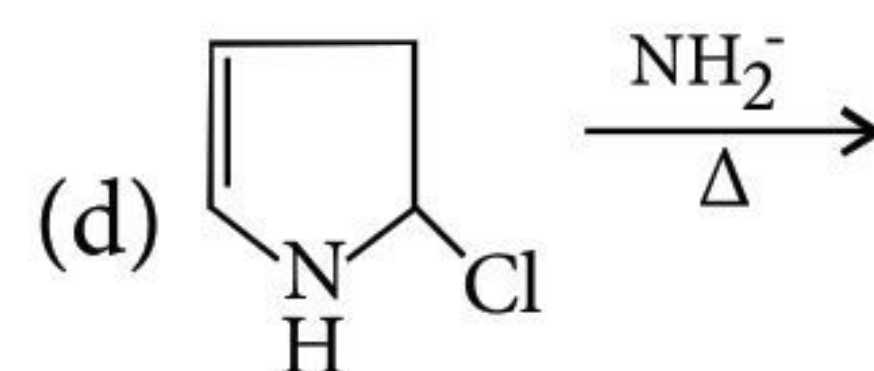
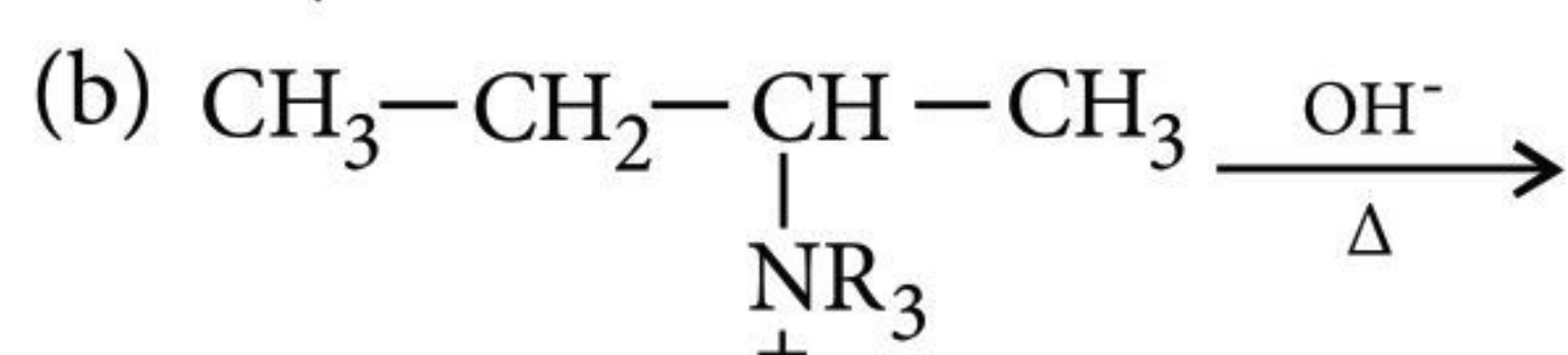
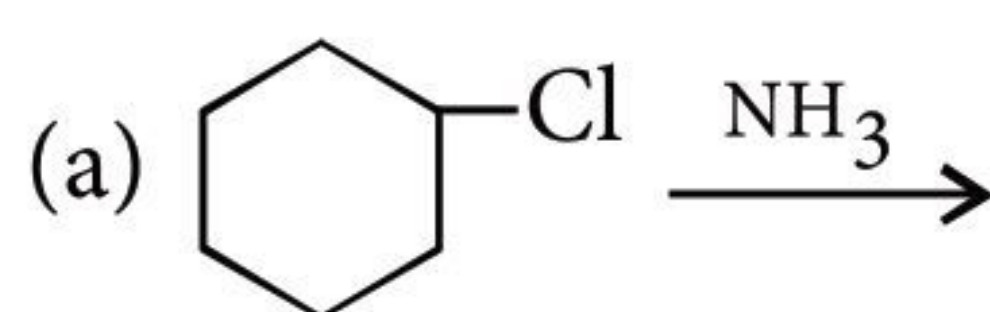


More than One Option Correct Type

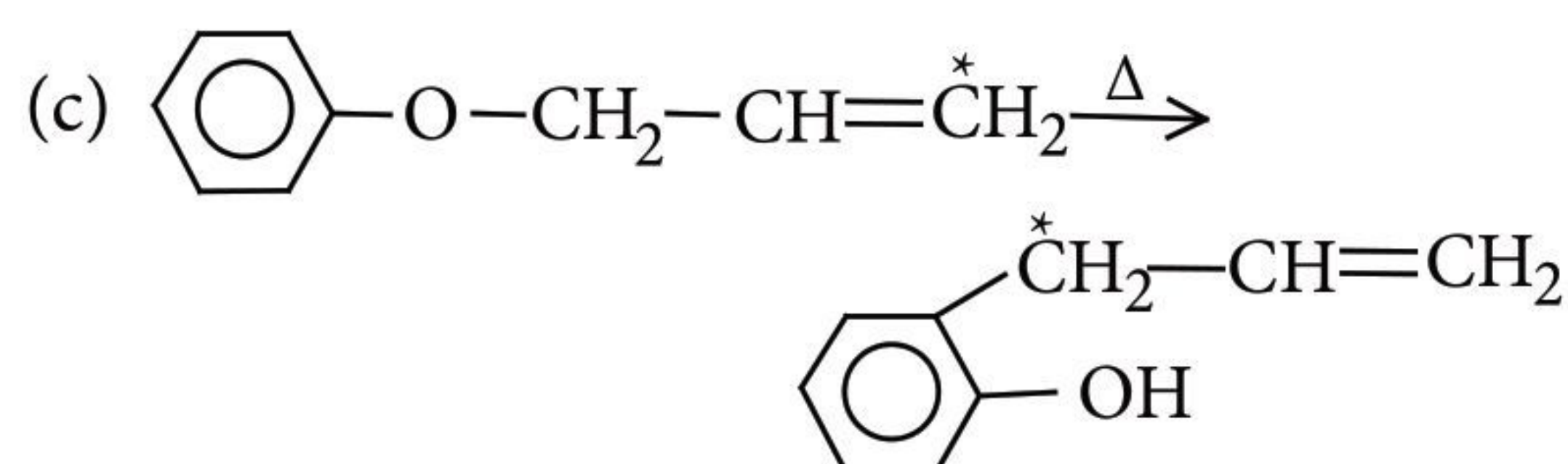
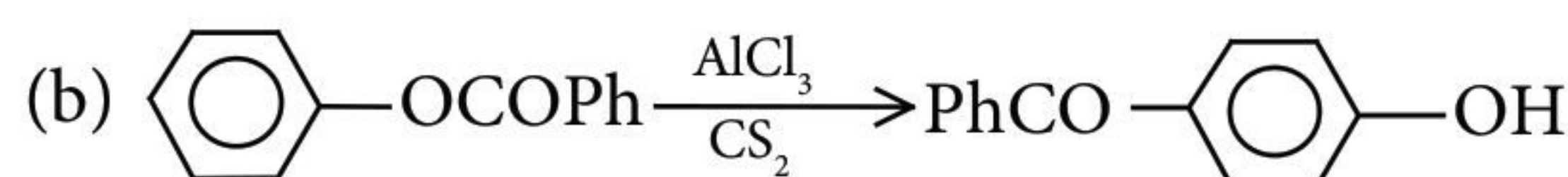
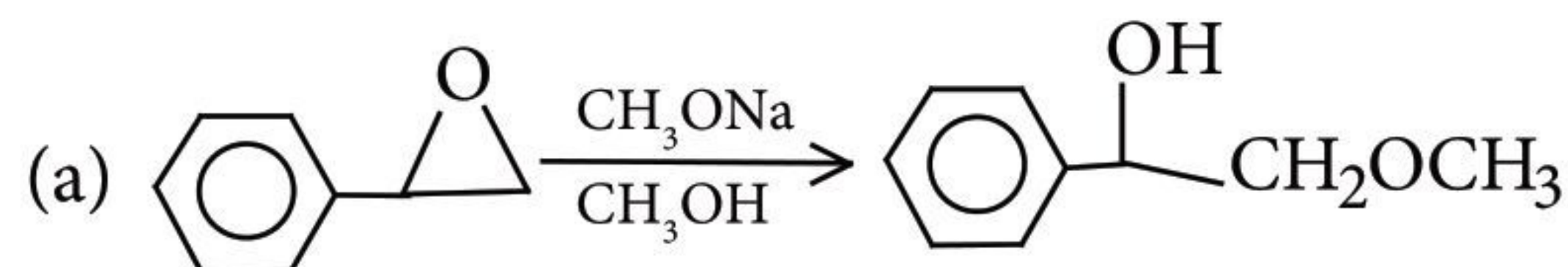
20. Fluorobenzene cannot be synthesised by

- (a) heating phenol with HF and KF
- (b) diazotisation of aniline followed by heating diazonium salt with HBF_4
- (c) direct fluorination of benzene with F_2
- (d) reacting bromobenzene with NaF solution

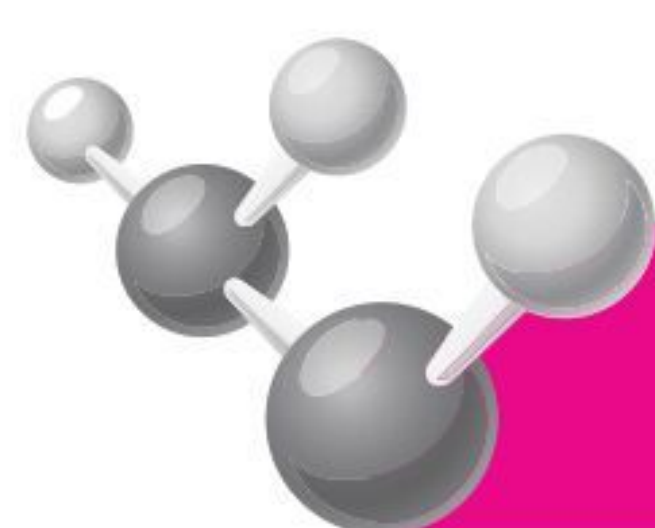
21. In which of the following reaction, elimination dominates substitution ?



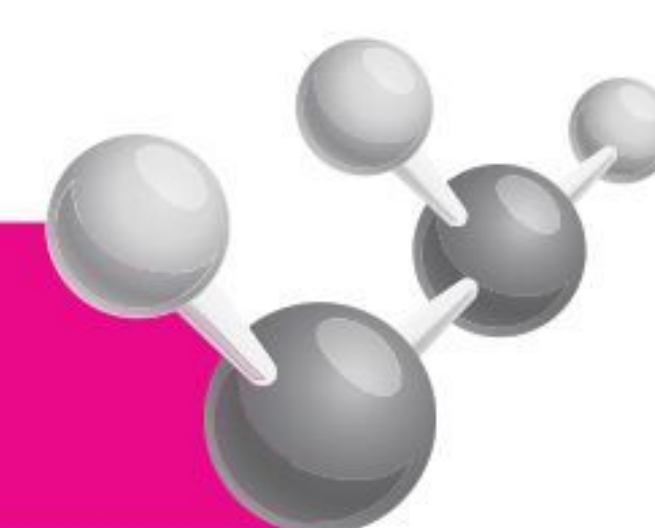
22. Which of the following constitutes a rearrangement?



(d) All of the above.



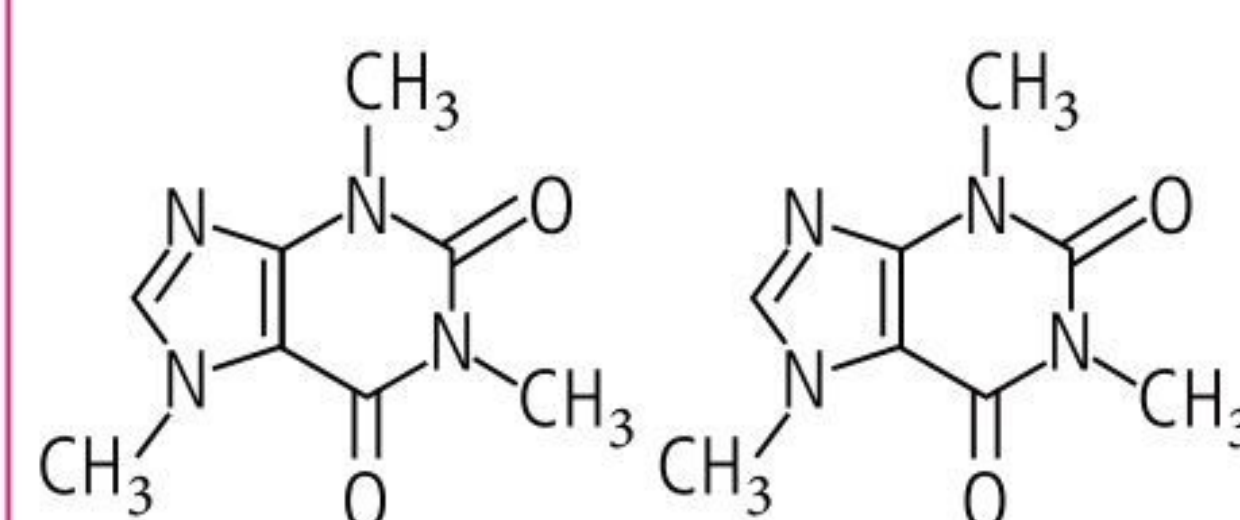
Amazing Facts You Must Know



1. What's the Difference Between Caffeine and Theine?

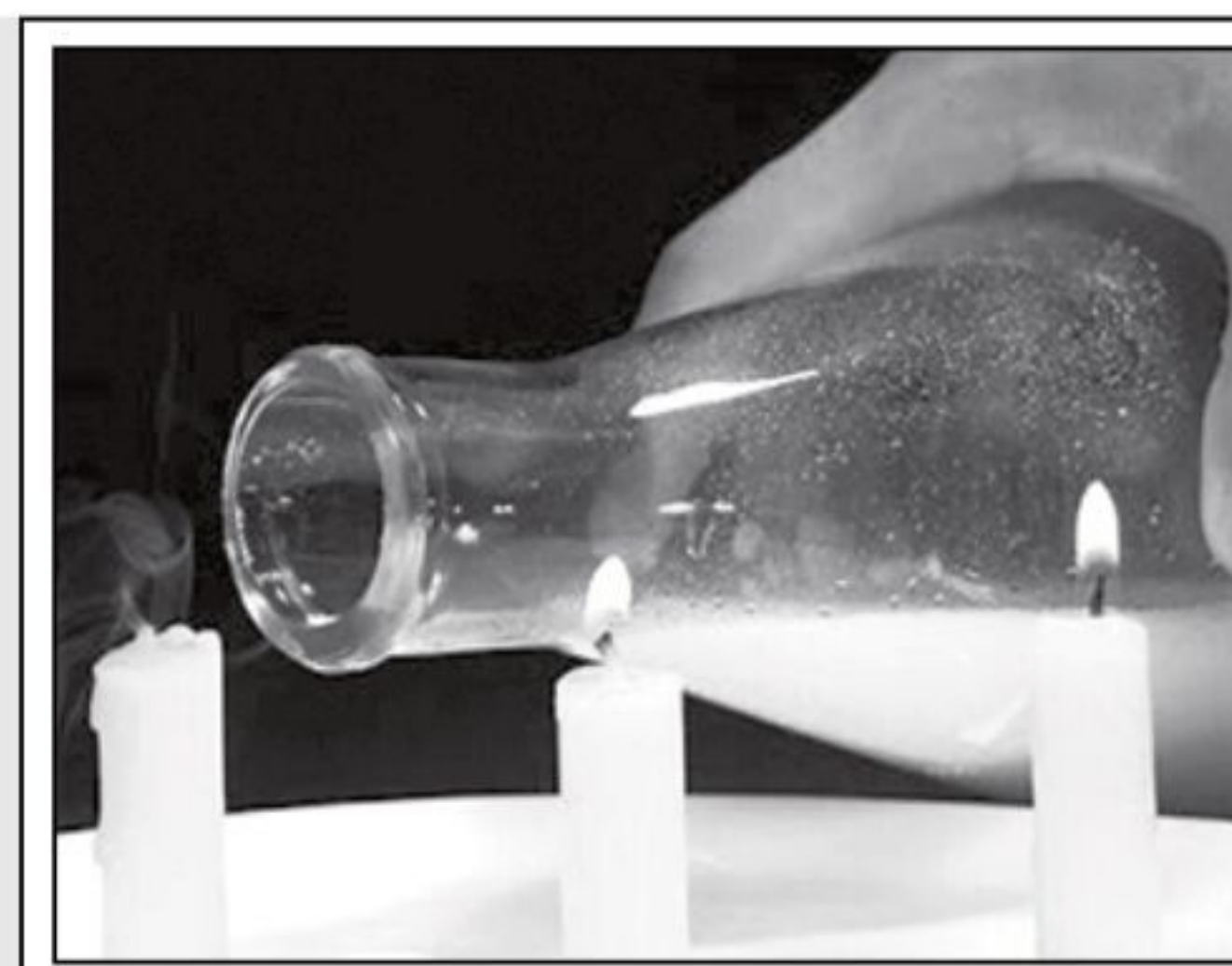
Caffeine was discovered first from coffee (1819) by a German chemist, F. F. Runge. The natural function of caffeine is to act as natural defense against insects, but also is a stimulant drug that makes us feel excited, making it easier for us to wake up in the morning. However, the term "theine" is actually a way to refer to "caffeine" when it is in tea. But the molecule is exactly the same. There are other active components in tea that have stimulant effects, such as theophylline, but they are much weaker than caffeine itself.

Caffeine Theine



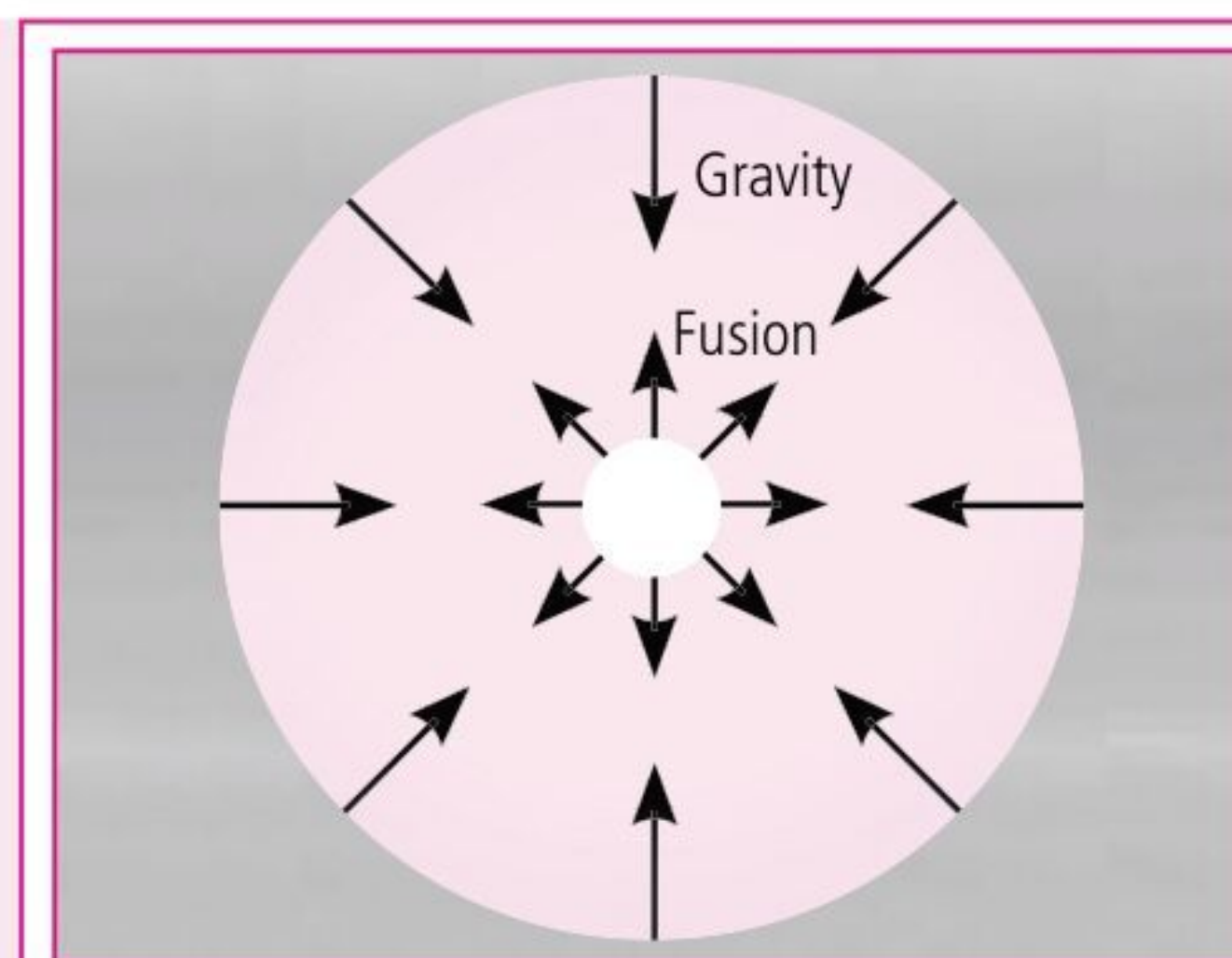
2. Can You Put Out a Candle with Home Made Carbon Dioxide?

Of course you can just blow a candle out. You also probably know that you can put it out by covering it with a jar or other closed container that prevents oxygen from getting in and fuelling the flame. There is actually a cooler way! You can generate a lot of carbon dioxide gas by mixing vinegar (acetic acid) with baking soda (sodium carbonate) in a glass. The mixture will start blowing out carbon dioxide, and you can pour carefully that gas (just the gas, not the liquid!) over a candle to put it out.



3. How Does the Sun Burn without Oxygen?

Sun is made mostly of hydrogen (besides helium), which is a highly flammable gas. But, as in the case of planet Uranus, there is no oxygen at the Sun. In classical terms, we need oxygen for a fire to burn. But the Sun is not actually on fire. Its heat and light come from nuclear fusion reactions, mainly combining hydrogen to make helium. This process does not require oxygen to happen.



23. Which of the following statements are correct for ethers?

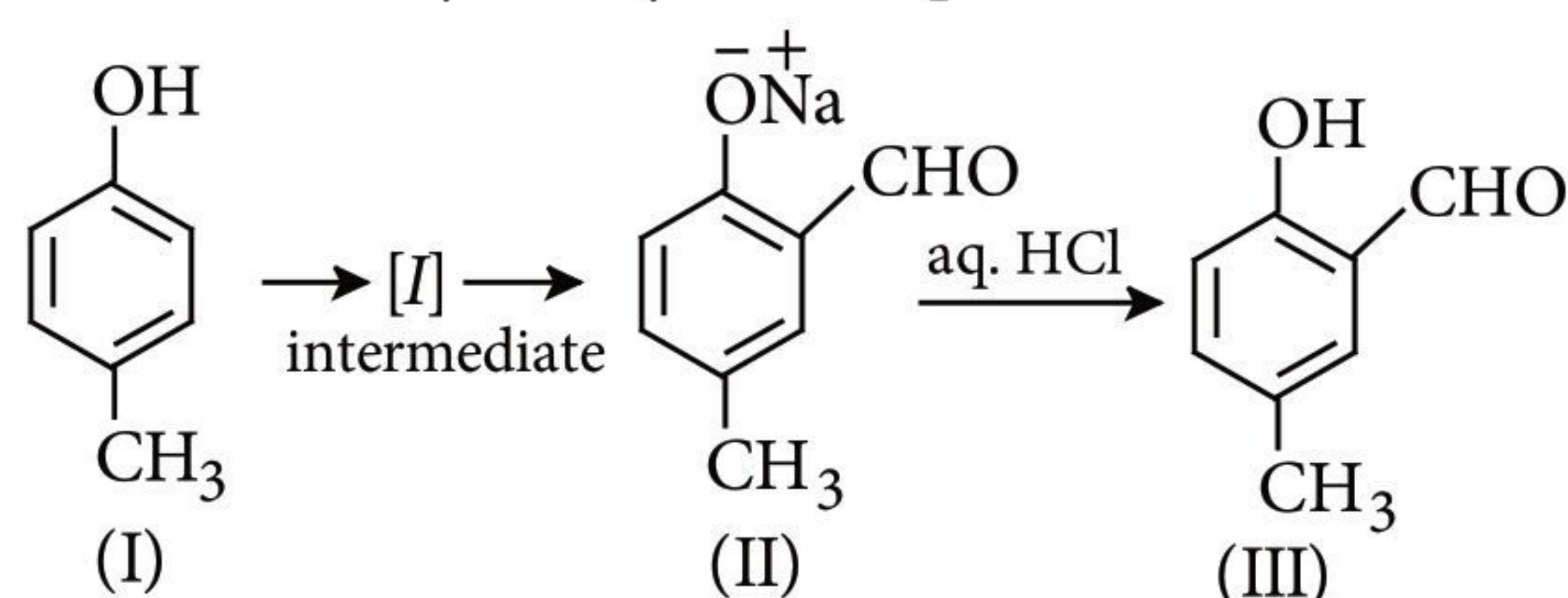
- (a) Being linked to carbon atoms, the oxygen atom in ether is comparatively inert.
- (b) The tendency of alkyl halides to undergo dehydrohalogenation in Williamson's synthesis follows the order $3^\circ > 2^\circ > 1^\circ$.
- (c) Traces of water present in ethers can be removed with Na metal because ethers do not react with sodium metal.
- (d) The bond angle in ether is slightly lesser than the tetrahedral angle due to repulsive interaction between two alkyl groups.

Integer / Numerical Value Type

24. Number of alcohol molecules formed on reaction of 3 molecules of propene, with BH_3 in THF is _____.
25. The change in oxidation number of chromium when Jones reagent oxidises primary alcohol is _____.
26. With alcoholic potash $\text{C}_3\text{H}_7\text{Br}$ (A) gives C_3H_6 (B). (B) on oxidation gives $\text{C}_2\text{H}_4\text{O}_2$ (C) + carbon dioxide and water. (B), with hydrobromic acid gives (D), an isomer of (A). The difference in the positions of Br in (A) and (D) is _____.

Comprehension Type

Reimer-Tiemann reaction introduces an aldehyde group, on to the aromatic ring of phenol, *ortho* to the hydroxyl group. This reaction involves electrophilic aromatic substitution. This is a general method for the synthesis of substituted salicylaldehydes as depicted below.



27. Which of the following reagents is used in the above reaction?

- (a) aq. $\text{NaOH} + \text{CH}_3\text{Cl}$ (b) aq. $\text{NaOH} + \text{CH}_2\text{Cl}_2$
- (c) aq. $\text{NaOH} + \text{CHCl}_3$ (d) aq. $\text{NaOH} + \text{CCl}_4$.

28. The electrophile in this reaction is

- (a) $:\text{CHCl}$ (b) $+\text{CHCl}_2$ (c) $:\text{CCl}_2$ (d) $\cdot\text{CCl}_3$

Matrix Match Type

29. Match the chemical conversions in Column I with the appropriate reagents in Column II and select the correct answer using the code given below.

	Column I		Column II
A.	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl} \rightarrow \text{CH}_3\text{CH}=\text{CH}_2$	p.	(i) $\text{Hg}(\text{OAc})_2$; (ii) NaBH_4
B.	$\text{CH}_3\text{CH}_2\text{ONa} \rightarrow \text{CH}_3\text{CH}_2\text{OEt}$	q.	NaOEt
C.	$\text{Cyclopentene} \rightarrow \text{1-methylcyclopentanol}$	r.	Et-Br
D.	$\text{Cyclopentene} \rightarrow \text{2-methylcyclopentanol}$	s.	(i) BH_3 ; (ii) $\text{H}_2\text{O}_2/\text{NaOH}$

- (a) A - q, B - r, C - s, D - p
- (b) A - r, B - q, C - p, D - s
- (c) A - q, B - r, C - p, D - s
- (d) A - r, B - s, C - p, D - q

30. Match the column I with column II.

	Column I Acid		Column II pK_a
A.	Phenol	p.	16
B.	<i>p</i> -Nitrophenol	q.	0.78
C.	Ethanol	r.	10
D.	Picric acid	s.	7.1

- (a) A - r, B - p, C - q, D - s
- (b) A - r, B - s, C - p, D - q
- (c) A - s, B - r, C - p, D - q
- (d) A - p, B - q, C - s, D - r



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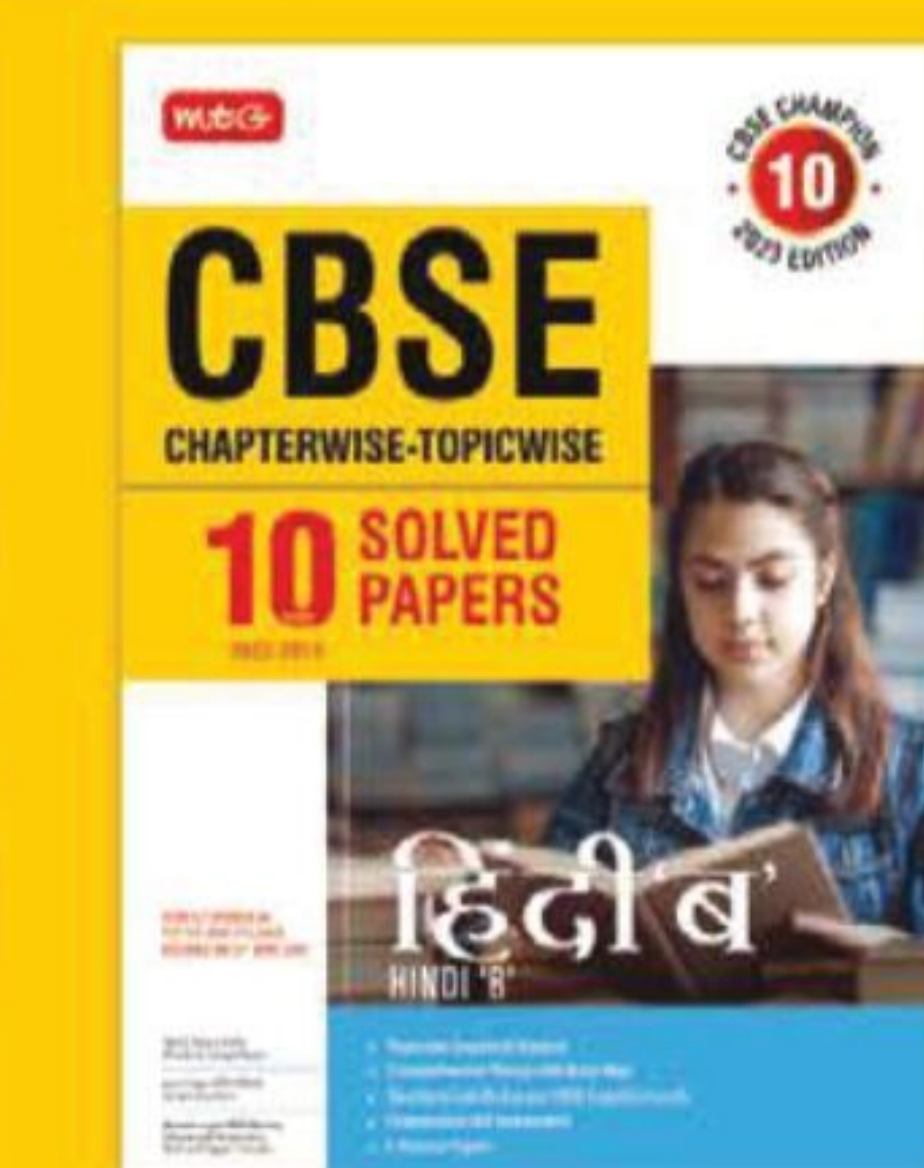
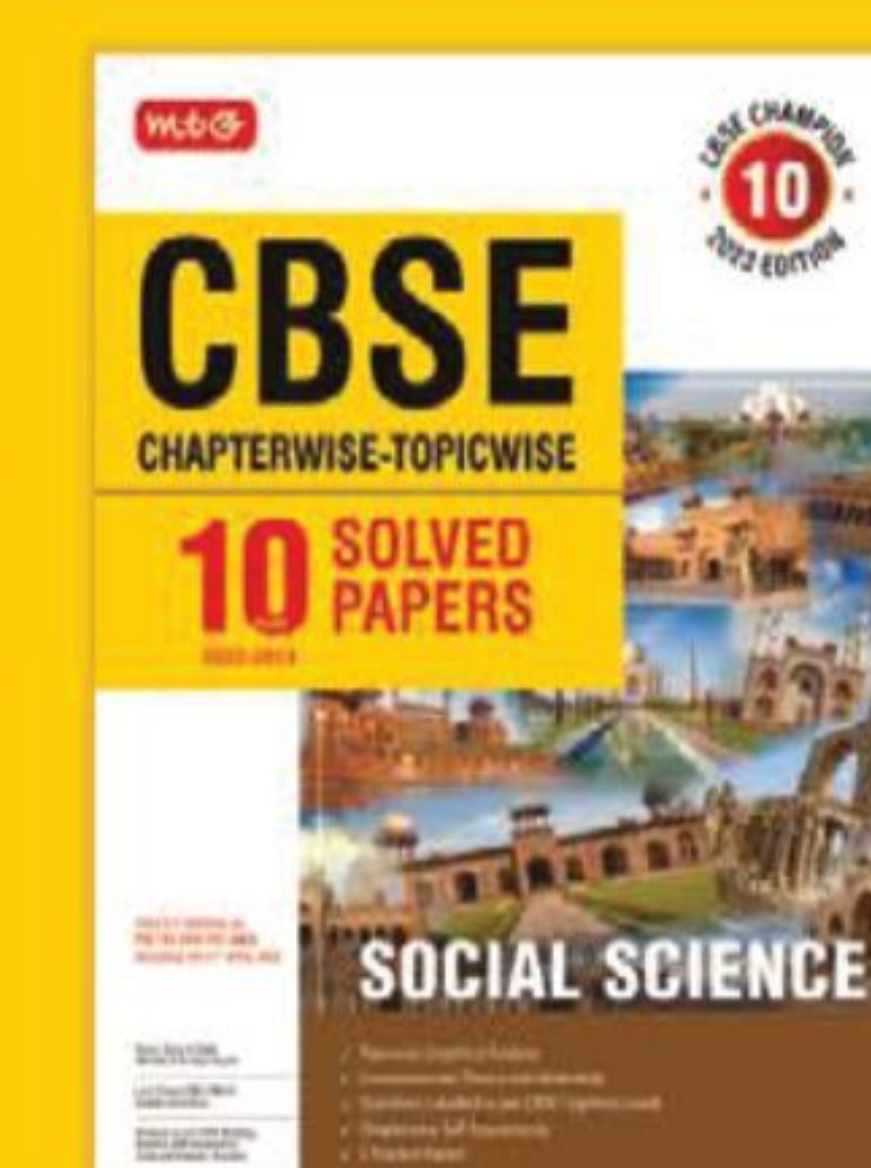
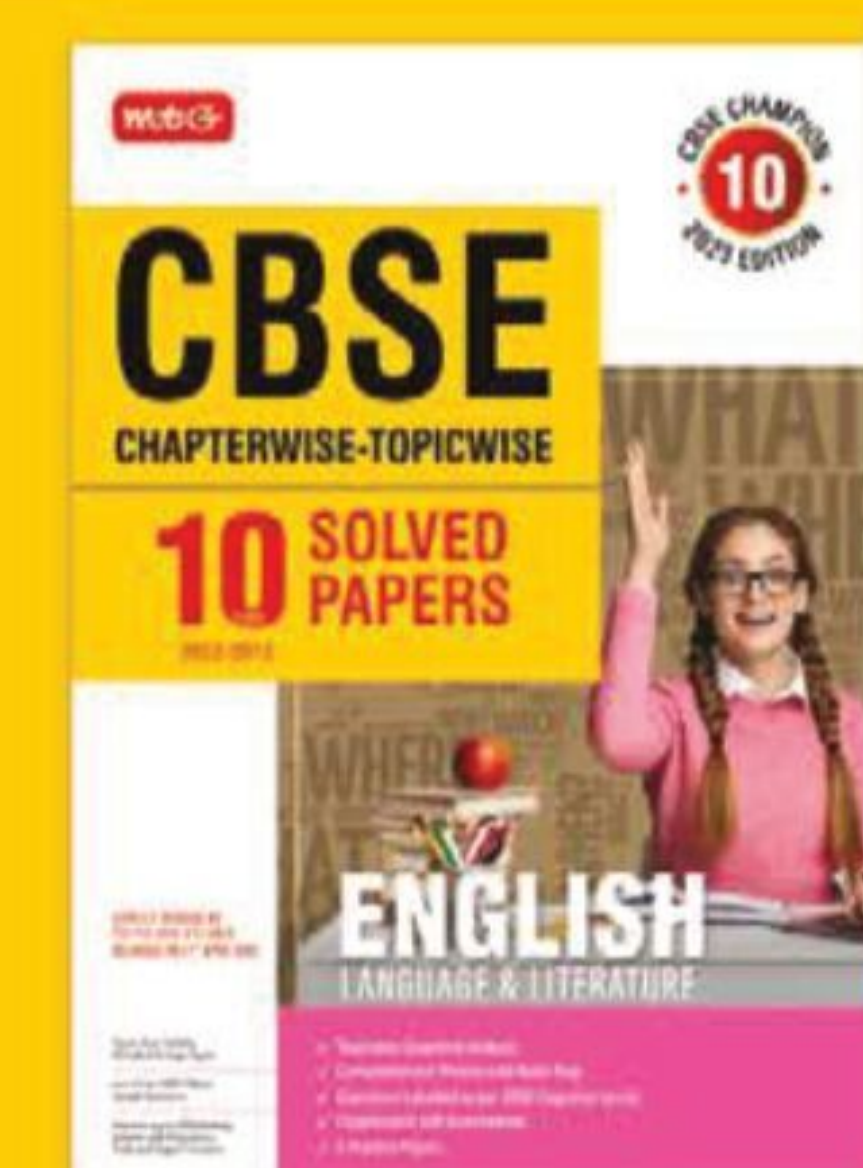
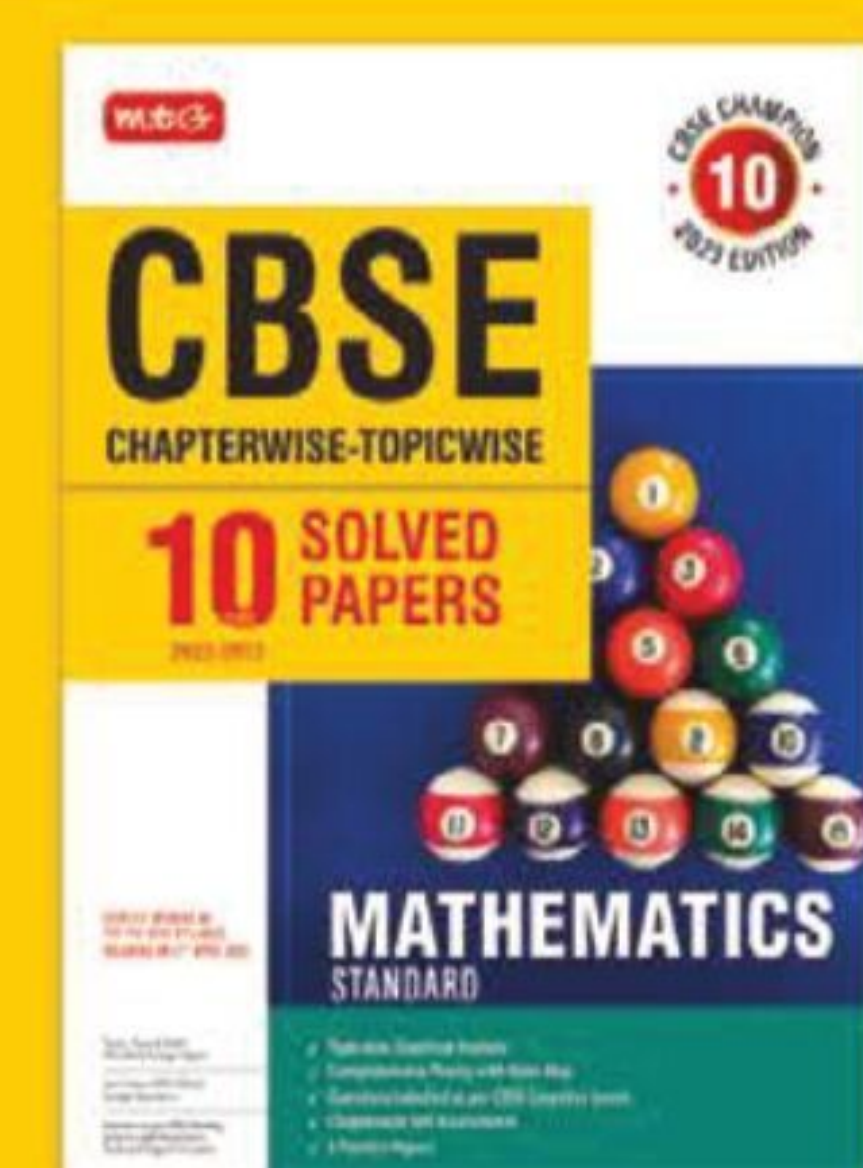
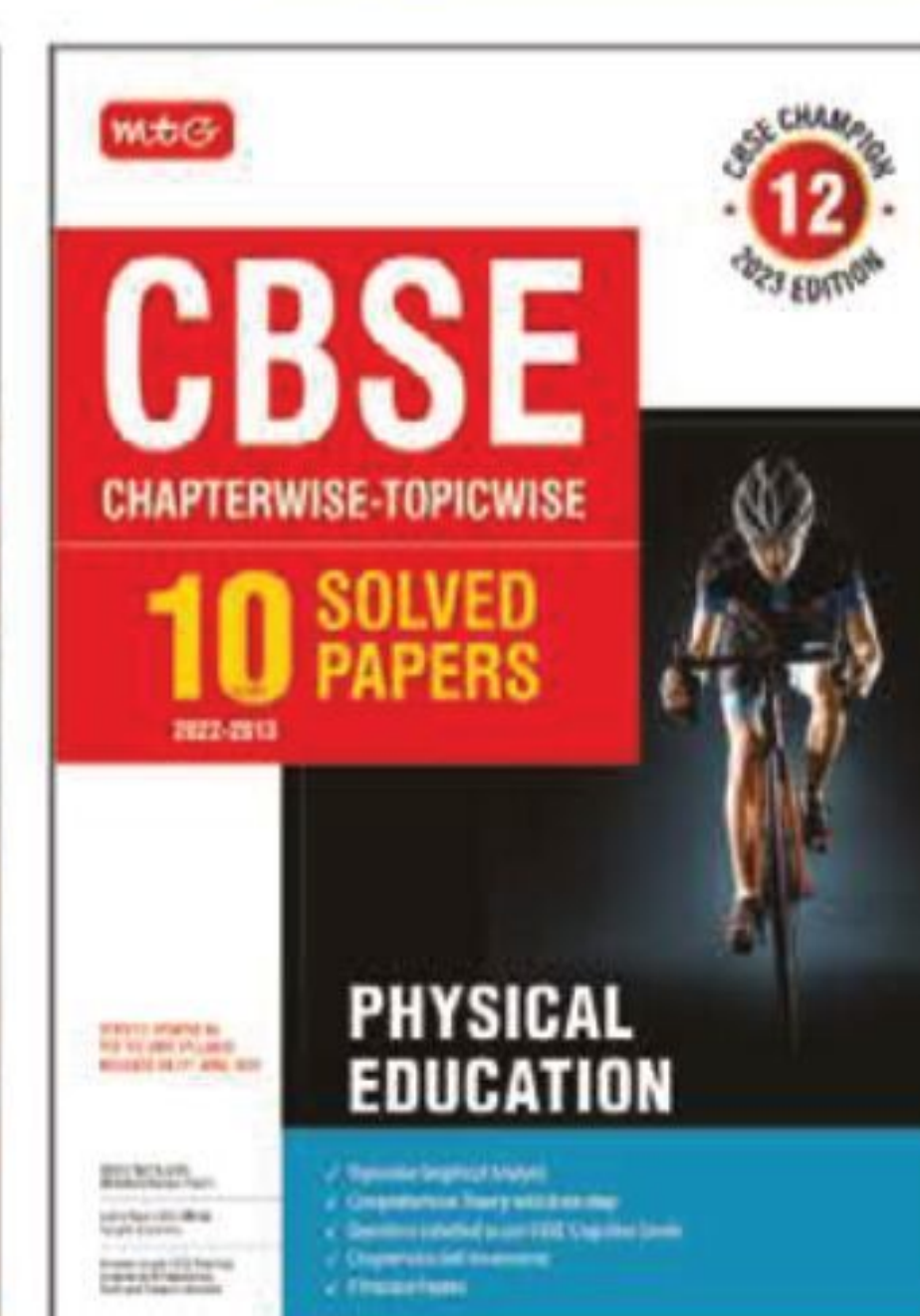
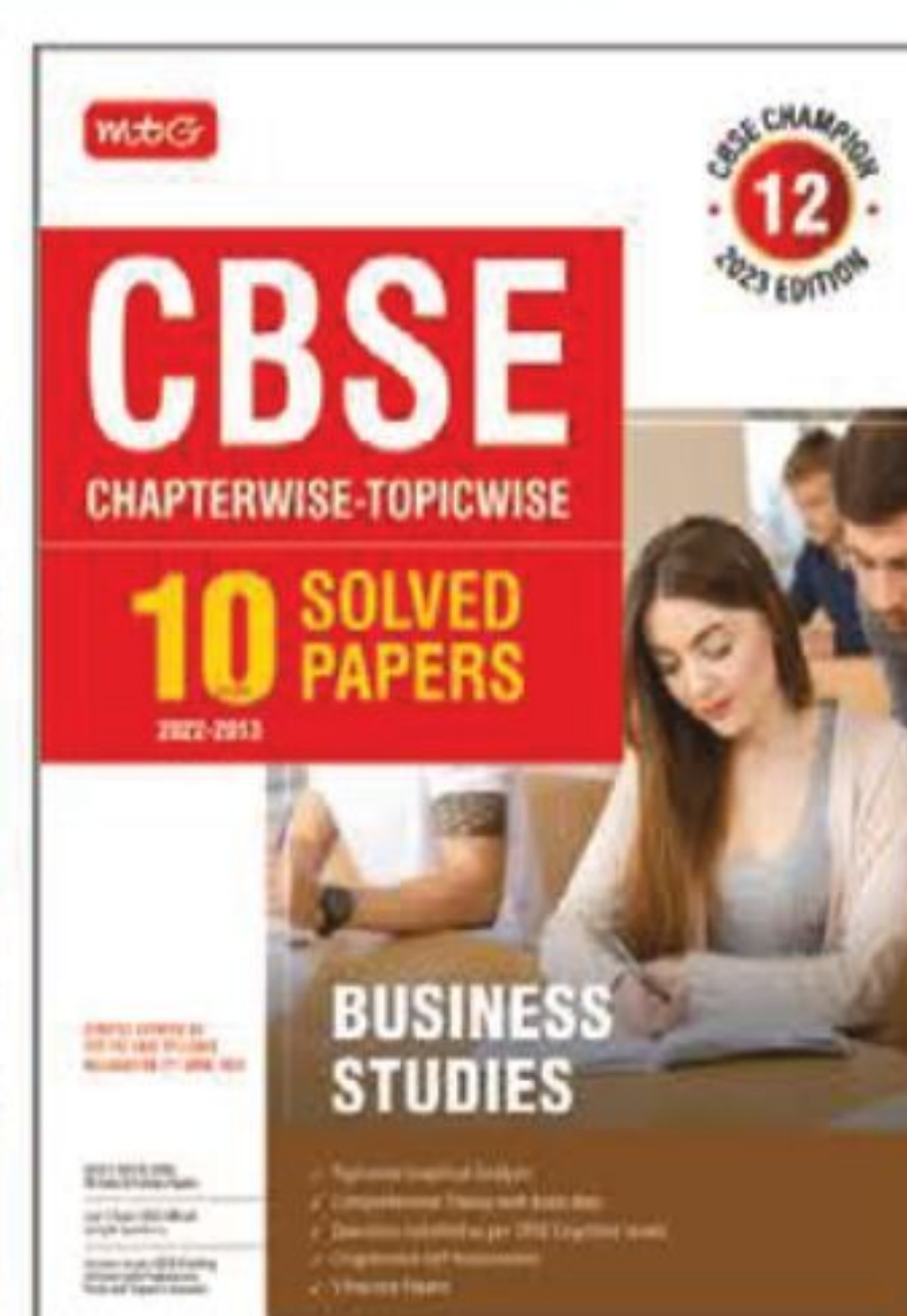
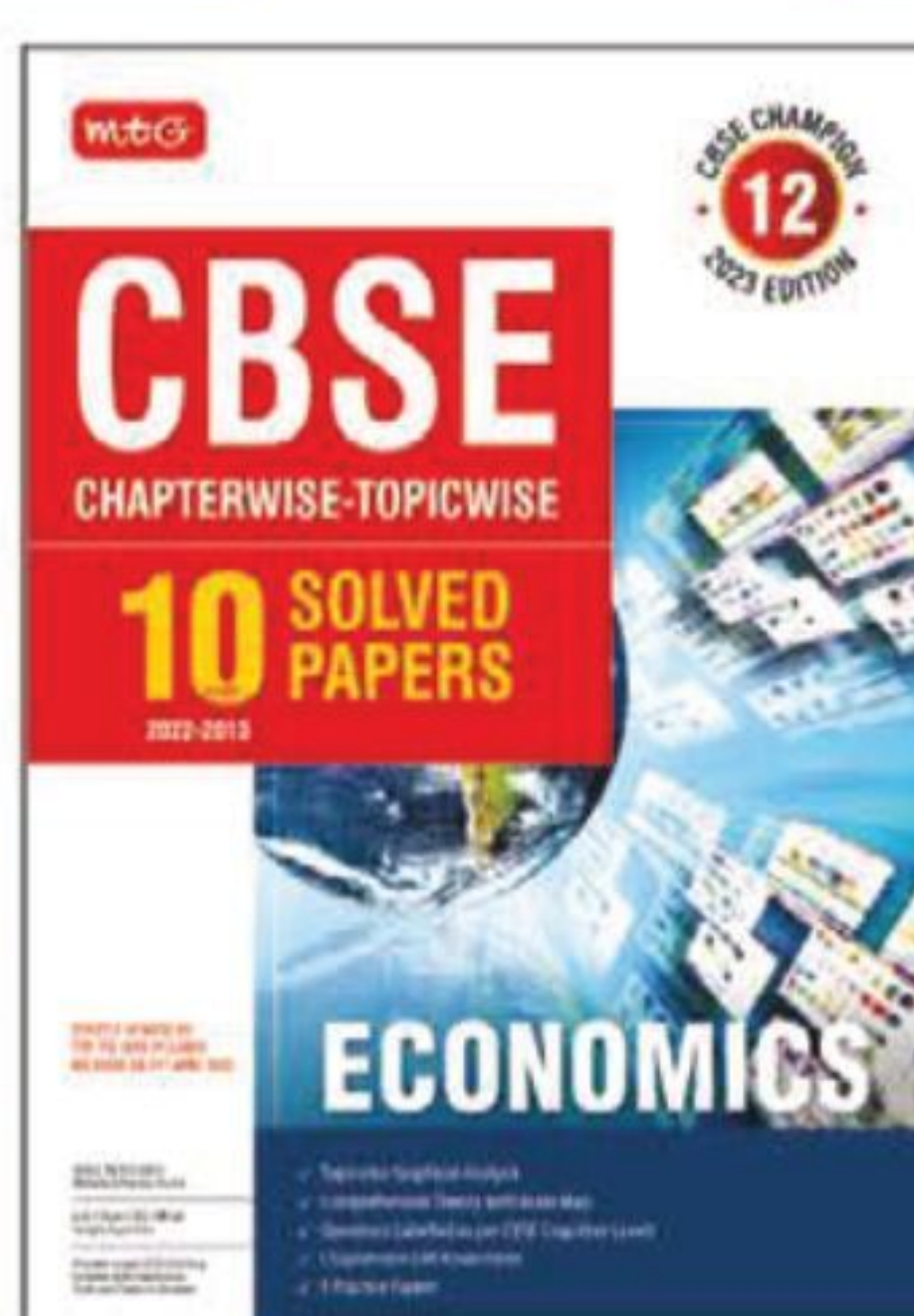
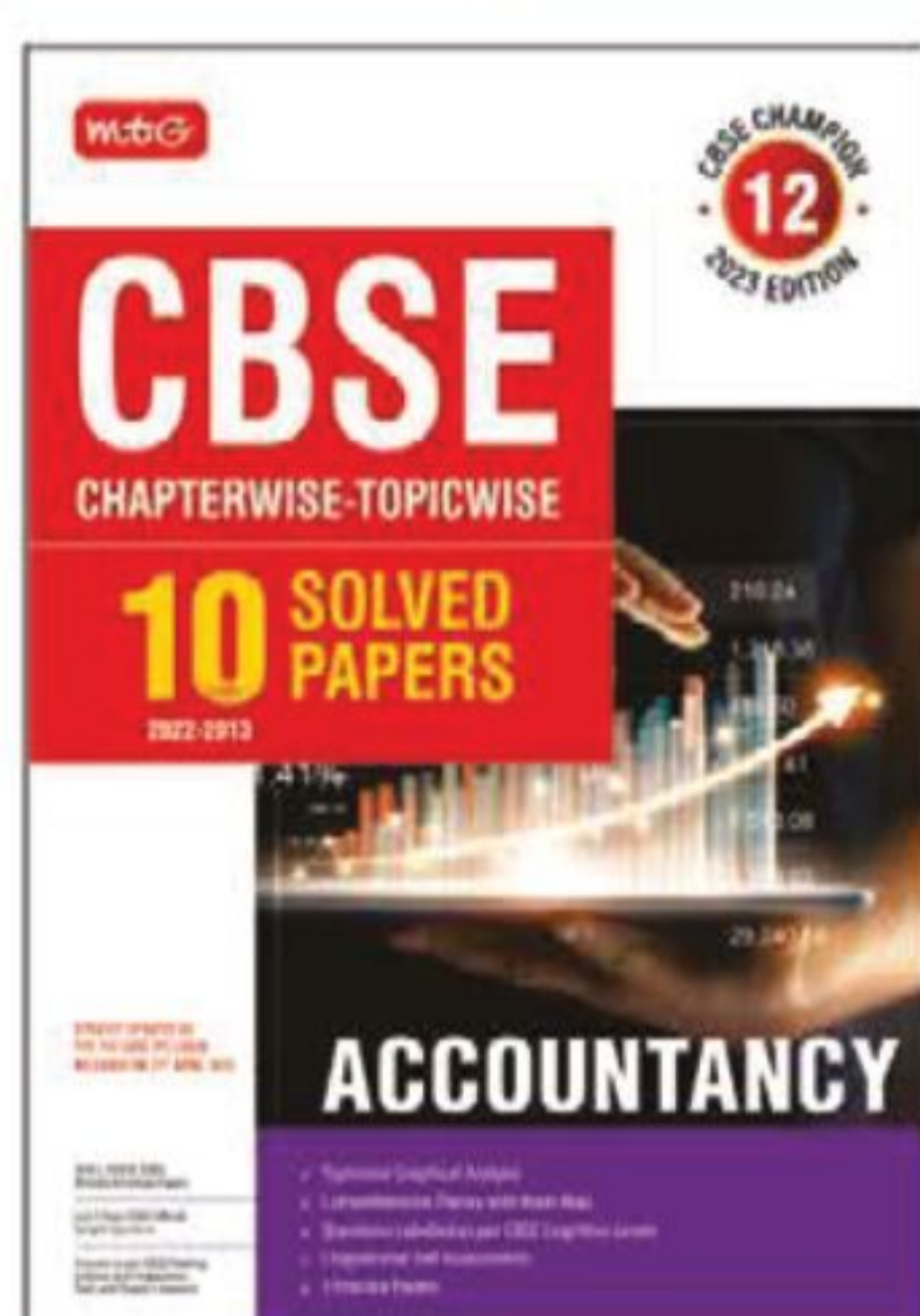
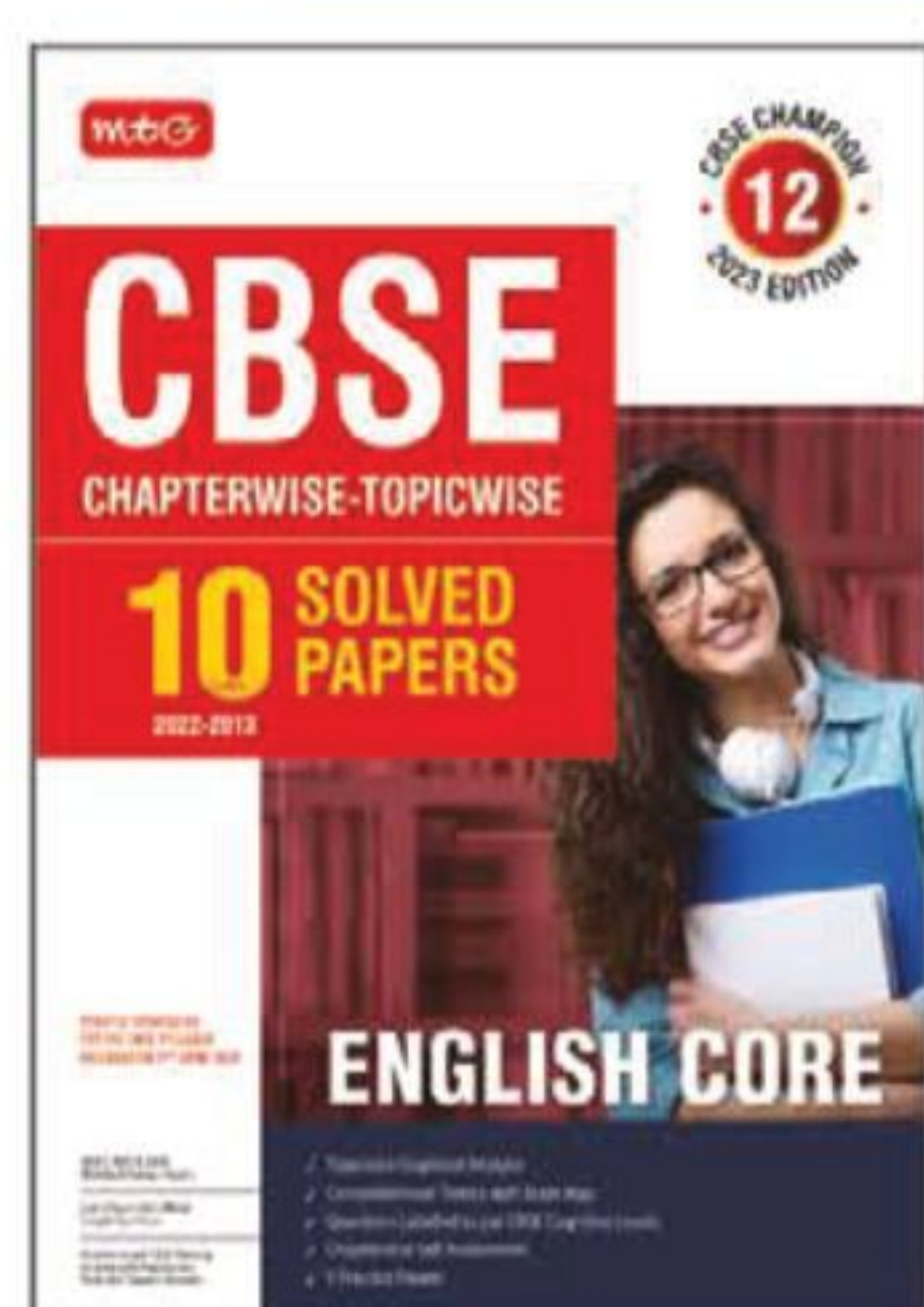
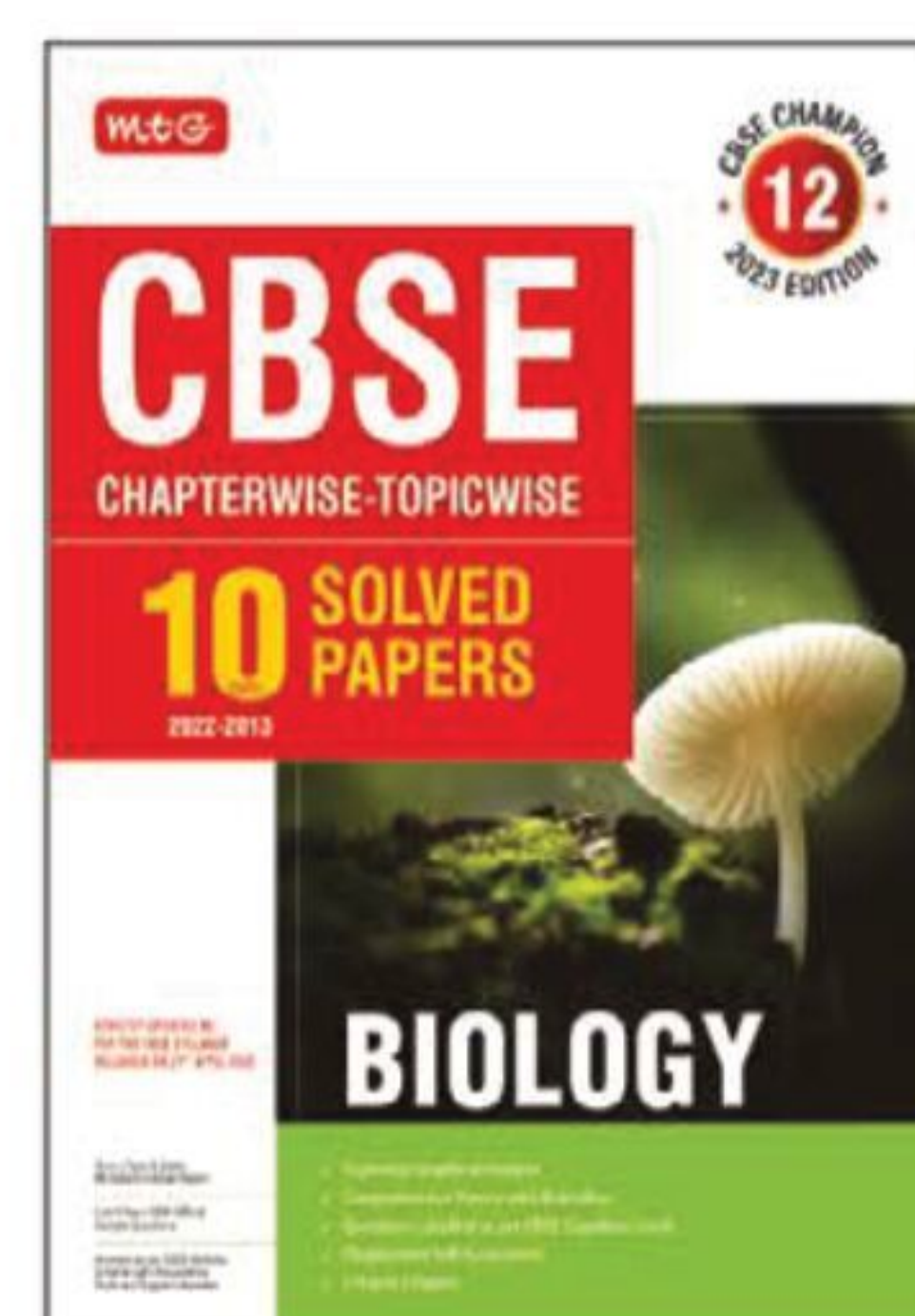
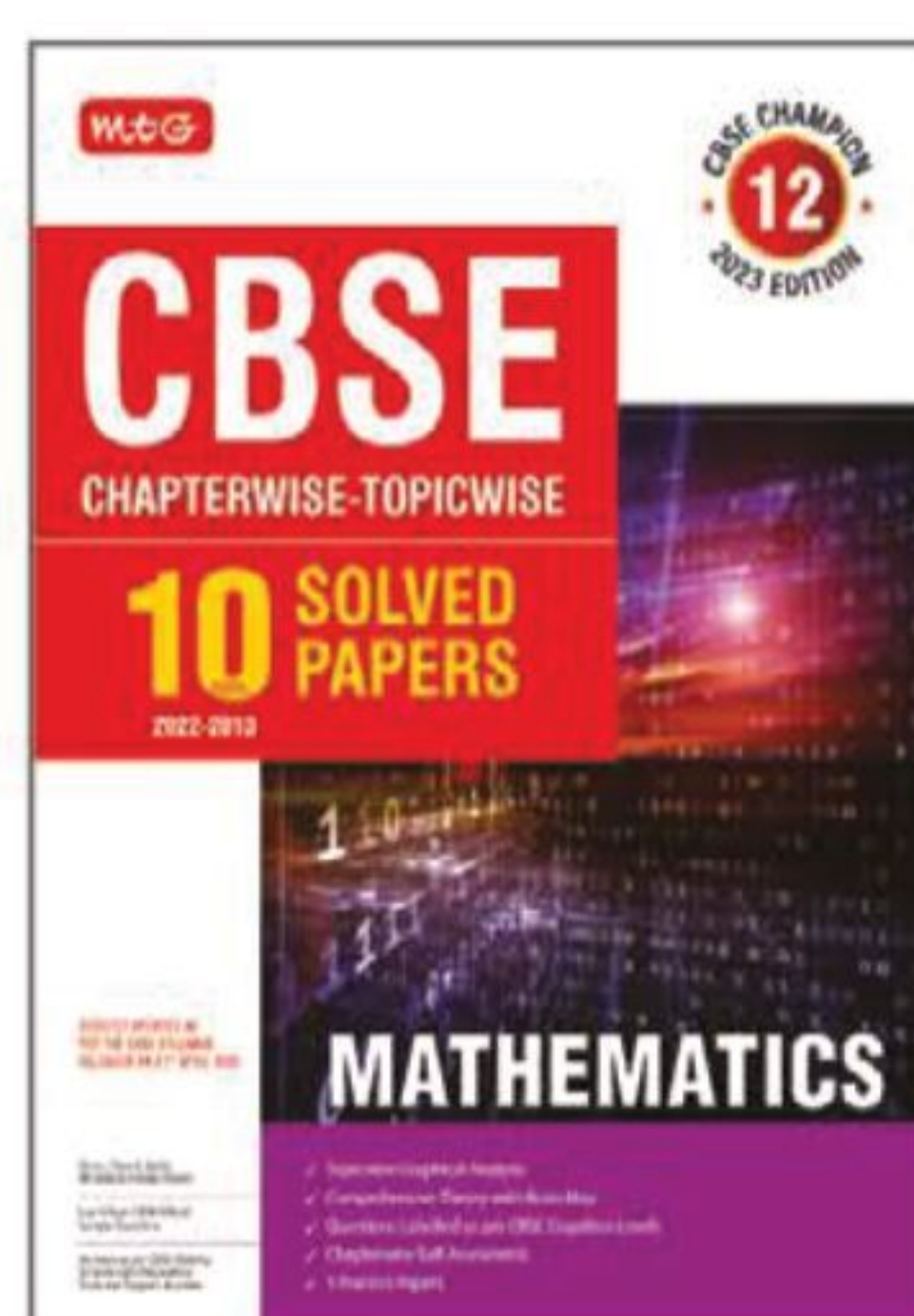
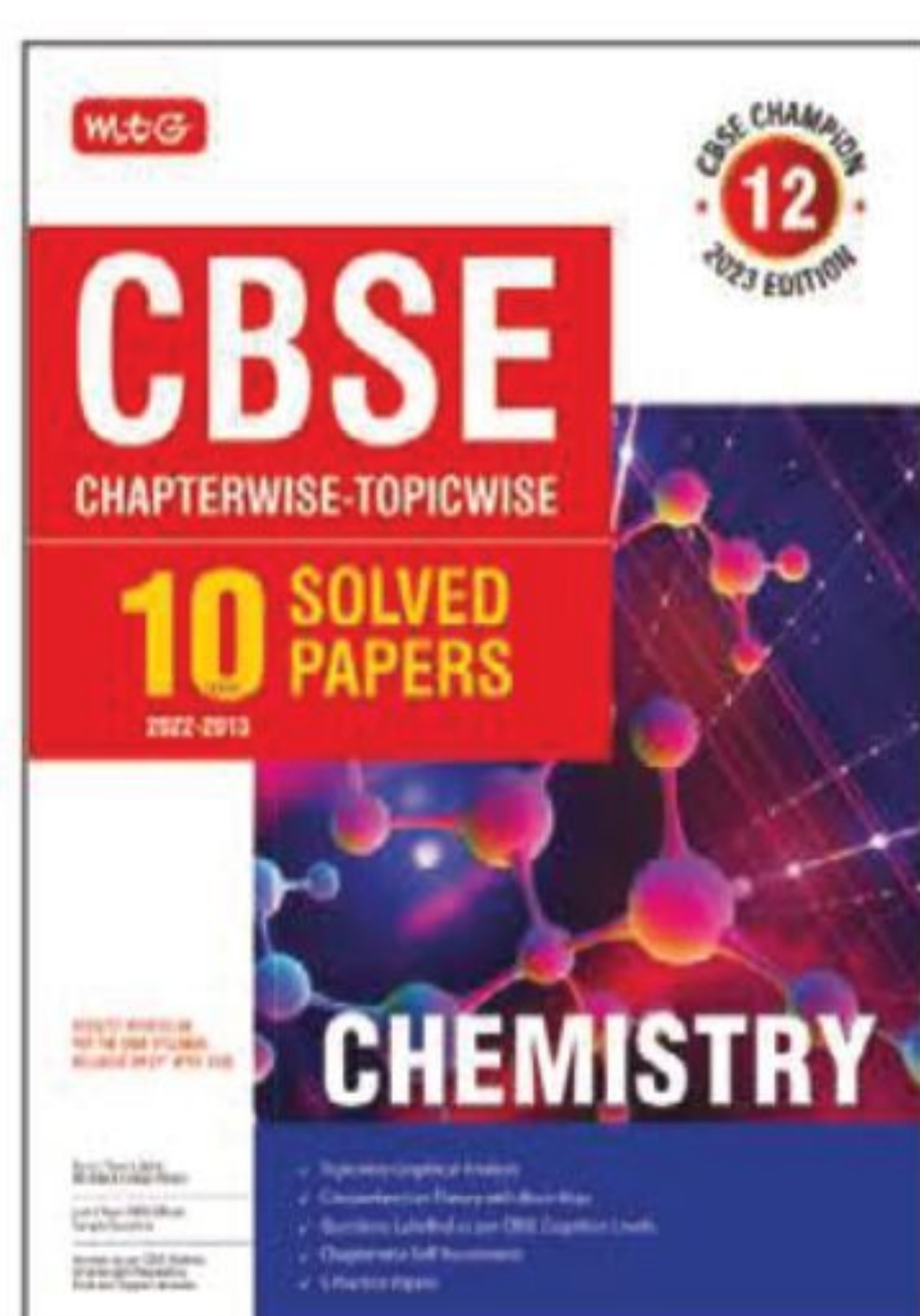
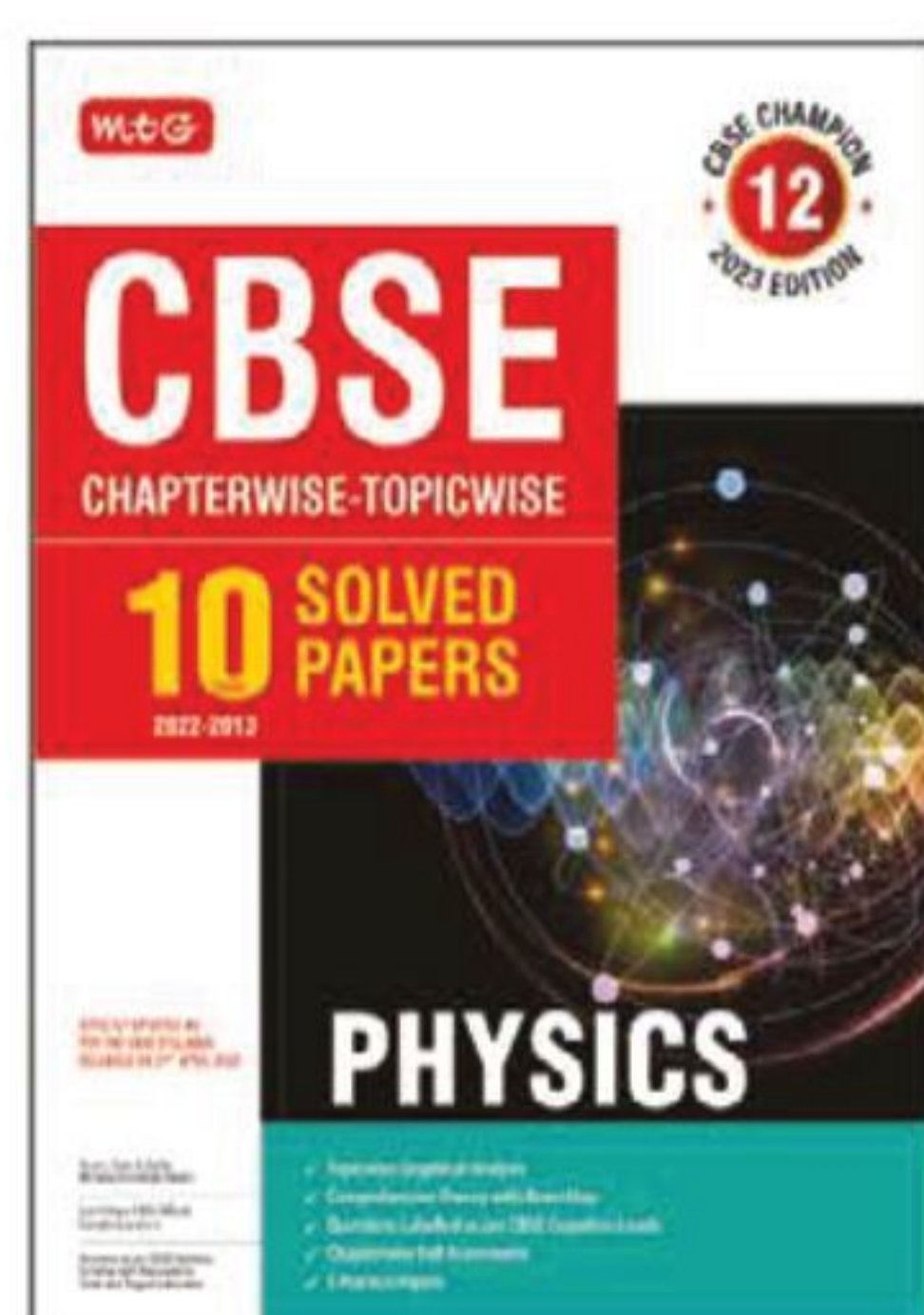
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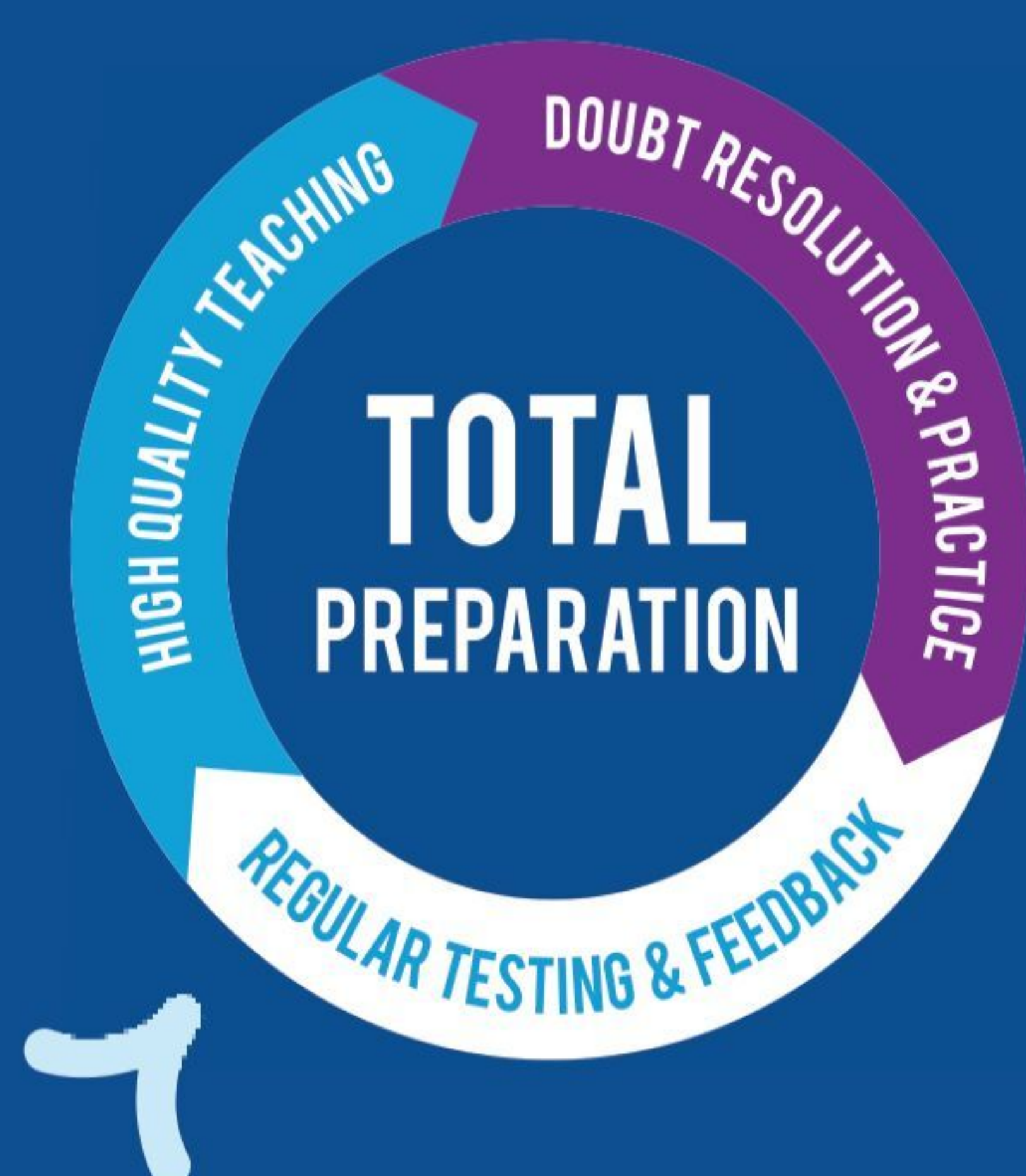
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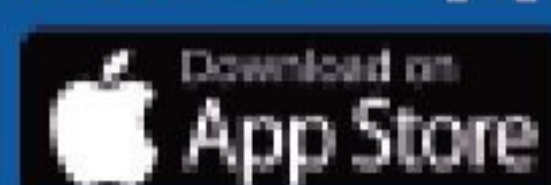
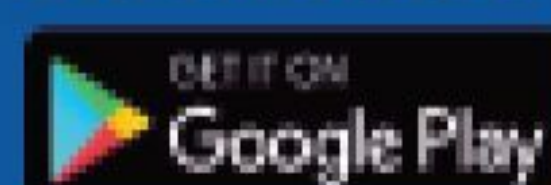


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